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The evaluation of different teaching styles and level partitioning teaching on the Bioinformatics of High Throughput Analysis course

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Introduction

During our course Introduction to University Pedagogy, we have been presented to different ways of performing active based learning in order to obtain a higher level of deep learning for the students. In order to test the implementation of different student activities, we have decided to implement three main types of teaching styles on the course Bioinformatics of High Throughput Analysis (BOHTA) for bioinformatics and biomedicine students. The three different teaching styles will be tried on three different course days. On day one of the teaching, we have planned to do short (fifteen minutes) lectures in a combination with small five minute Teaching and Learning Activities (TLAs). Day two will start with a thirty-minute introduction to the theoretical topic followed by the students working in groups on a case-like problem. Finally, on day three the students will work in groups on a case and prepare a presentation of their work followed by a presentation in class.

The evaluation of the different teaching methods will be split into different categories. At first we would like to ask the students at the end of each session to describe how they experienced the teaching (including what they found the best or worst, how much work and energy it demanded and how much they think they learned from the session).

We will also try to evaluate the teaching by one of us monitoring the session and notice the amount of questions and the activity amongst the students during the session and try to evaluate the outcome of the teaching style based on the students' answers to questions.

It will also be interesting for us to evaluate how the different teaching forms worked for us as teachers, what did we feel the most comfortable with, what was maybe too routine, and was anything more challenging? (like letting go of the control).

Finally, we will try to evaluate the outcome of offering students level partitioning teaching, based on their requirements for more biology or computational learning. This will be based on the evaluation of assignments handed in during the course and the final grade obtained this year compared with the previous two years. Unfortunately, the evaluation of the effect of level partitioning will be done after we have handed in this assignment due to summer vacation.

Inspired by our own experience and the work of Mazur (1997, 2009) we would generally like to move away from the traditional information transfer model in the normal lecture format and increase the focus on activating the students and try to improve their deep learning. One way of achieving this could be through group work, where the students are encouraged to go through the material covered in the previous lectures and explain this to the other group members. This of course requires that the students have paid attention during the lectures and are not afraid to share their knowledge.

Course description

The BOHTA course is mainly for students in the Molecular biomedicine or Bioinformatics study programme. The purpose of the course is to give the students tools for computational analysis of large biological datasets. This includes understanding the biology and laboratory techniques used to obtain the datasets as well as understanding the statistical and informatics techniques used for analysis of the data (Appendix A).

In previous years the students from Bioinformatics have requested a better introduction to the biology behind the large datasets instead of using a lot of time on basic programming in R. Given the very different requirements from the students, the course responsible decided this year to try and split the students for the first four sessions (each session being three times fifty minutes). The students with a biological background could choose four sessions with introduction to programming in R. Then the people with sufficient programming skills could choose to attend one session with a very short introduction to R followed by three sessions of introduction to the biology behind the datasets.

We have a strong biology background and experience in using these experimental techniques and were therefore asked to be responsible for teaching the three sessions with focus on some basic biology and the experimental techniques needed to understand the nature of the large biological datasets that they will need to work with later in the course.

Session 1

We first tried with the most standard way of teaching on this course. We have previously tried to stand and lecture for fortyfive minutes straight and were not interested in trying this again based on previous experience with a decline in concentration from everybody during these forty-five minutes (see Fig. 12.1).

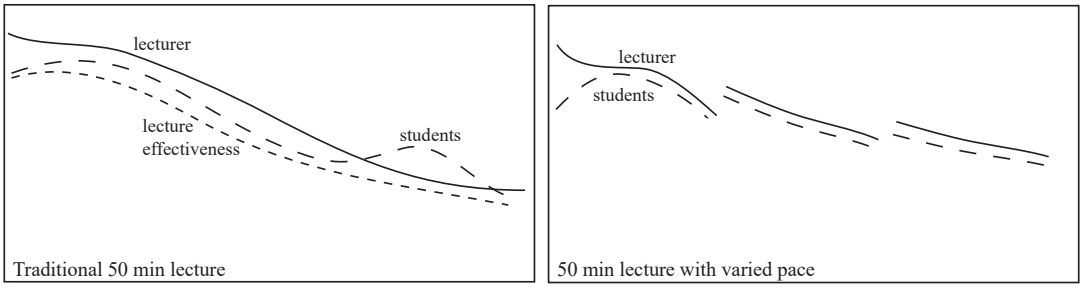

Fig. 12.1. The decline in student attention and lecturer performance from the start to the end of a traditional fifty-minute lecture. A rest, questions or simple exercises that varies the pace may produce the desired result. Based on Bligh (1998) after Lloyd (1968).

We decided to try with several short (10-15 minutes) lectures using PowerPoint slides and writing on the board. Each short lecture was followed by five minutes of exercises in groups of two.

Evaluation from the students on session 1

At the end of each of these three sessions we had set aside five minutes where we handed out an evaluation form to the students and asked them to fill these in.

The overall comments from the students were positive about the structure of the session. When asked if the exercises increased the learning outcome relative to time consumption most of the students without a biological background felt it was useful for understanding the theory better:

> "…, it was a 'plus' in the course structure, I understand better the theory."
> "yes, the practice helped a lot"
> "yes, I think that the exercises were entertaining"
> Also the students with biology background had an overall positive attitude towards the exercises.
> "good for visualization, but not really necessary"
> "yes, especially if the concepts seemed to abstract"

However, also a more negative comment was returned: "Perhaps slightly less time could be spent on exercises if exercises were done individually, less time would be used."

Observation of students during session 1

A couple of students were surfing the Internet and were only participating during the exercises. We later found out that these students all had a biology background. A small group of students with a non-biological background was very focused, but were lost during the heavy theory slides. However, they actively participated in the exercises. The rest of the students were paying attention and able to ask questions and participated in the exercises.

In conclusion, we had a very heterogeneous group of students in relation to the professional starting level. The course was aimed at students with a very limited biological understanding, next time we should make sure to eliminate the students with a strong biology background, since they made the non-biologists feel inferior and this can perhaps hold back some of their questions.

Our evaluation of session 1

The day after the session we sat down and discussed the experience of the teaching. We both agreed that the students seemed active during the session and participated in the exercises and came up with answers. But we both experienced a time pressure with too little time for both lecturing and exercises. In order to make five minutes for exercises we found that we had to compromise with the level and complexity of the exercises. It was also

difficult to make time to talk or help out all the groups, especially as we experience the importance of formulating a very precise five-minute exercise without making it just a pop-quiz repeating the material just taught.

We concluded that in future teaching situations small student activities could be helpful, but perhaps in a combination with questions of more clarifying character especially in smaller classes like ours.

Session 2

On the second day of this course the students would hopefully have the basic biological knowledge and we would like to increase the length of the group exercises in order to cover more advanced questions also using cases. The case study as a method pedagogically engages the students in analyzing, evaluating, conceptualizing and discussing applications (Kunselman & Johnson 2004). According to Holkeboer (cited in Kunselman & Johnson (2004)), it also makes the students develop a three-step critical-thinking process, where the students identify the core problem, brainstorm over possible solutions and find the best solution. The case exercise facilities critical thinking, which is one of the learning objectives for our students.

So on this day of teaching, we had two sessions (one each) where we lectured for approximately thirty minutes and then had time for thirty minutes of group work with a case based problem followed by a discussion. The exercises were problem solving, where the student had to use the techniques just lectured about.

Evaluation from the students on session 2

In the evaluation of the exercises relative to time consumption the answers vary somewhat. Some were positive:

> "Yes, the exercise was better today. They were less time consuming and actually raised some good questions."
> "Yes, I believe the exercises always help!"

However a large fraction of the students felt they had too much time to do the assignments:

> "yes, even though it was too much time given for them. It could have been a little bit shorter and maybe encourage more discussion"
> "it was good with teaching and exercise but the exercises were short in relation to the time"

Finally, a fraction of the students did not like the exercises.

"Not really. I don't think that's the best way for be to learn anyway."
"I think that the exercise today were not that helpful."

Observation of the students during session 2

During this session we had that same pattern of behavior from the students during the lecturing part, that some were surfing the net, others paying attention and asking questions and finally the students without any prior biological background struggling to keep up. During the exercises the students were allowed to form groups by themselves and administrate a break, resulting in some of them having very long breaks until the common round up. During the round up, it was mainly the students with a strong biology background that came with input and we as teachers ended up giving many of the answers.

Our evaluation of session 2

Discussing the teaching the next day we both had the feeling that 30 minute lectures seemed to function well for having time to introduce more advanced topics. The 30 minutes also provided us with enough time to ask or receive questions during the lectures from the students, making time for clarifying or repeating areas that can be difficult to comprehend. Our experience of the exercise was that it was not well enough structured to signal clearly what we expected them to do in the thirty-minute exercise. The purpose of the session should be stated more clearly at the beginning of the session. We also anticipated that the students were able to time-manage inserting a break in their group work, however this did not seem to be the case. Learning from experience the assignments given should be very well structured with direct questions to be answered and with sub-assignments to guide the students during their group work.

Session 3

This was the final day of teaching and inspired by the cooperative learning teaching method (described in Schmidt (2006)), we wanted the students to

try and work with the theory on their own in groups. Also they had to evaluate and give feedback to the other groups. As we previously experienced the importance of a thorough introduction, we started with five minutes introduction and then two hours of group work, while the session was finished with presentations by the students. This required the exercise to be quite structured so that the students knew what they were expected to do, since two hours is otherwise a very long time. Taught by experience we formed the groups in advance as well as administrating their breaks. We finished this session with the groups presenting their work in class and evaluating and discussing the presentations and results.

Evaluation from the students on session 3

At the end of each of these three sessions we had set aside five minutes where we handed out an evaluation form to the students and asked them to fill these in. The overall comments were generally positive:

> "Discussing is a very good way to learn and to practise"
> "And by commenting and summary in the end we learned many things."
> "Yes, the relaxed atmosphere led to interesting discussions."
> "It was interesting to have to actively think about those features instead of passively learn about them"

Some did not feel the content was challenging enough, however, they did not oppose the structure of the session.

Observation of the students during session 3

During the group work all the students participated in the internal discussions, of course some were more active than others. When going around between the three groups very different point of views and approaches could be observed. As this time we had made it clear to the students that all members of the group should present part of the work done by the group and that it was the responsibility of the group to make it possible, a lot of student teaching student took place. During the presentations all members of the groups showed an understanding of the subject. The rest of the students were asked to take notes for questions after having heard presentations from all three groups. In the final round up where the students should collect all the inputs presented by the three groups into one suggestion, the students were active, coming up with points to be included into the final product.

Our evaluation of session 3

In the evaluation of this session, we both felt that the session had gone well and that the atmosphere had been good with students participating actively. This time we had made the exercise more concrete, but still with open answers as the students had to design their own visualization tool, which could be done in a variety of ways. During the exercise there was enough time for the students to sit and discuss the different parts of the exercise as well as asking us questions, thus covering the theory presented in the previous two sessions. Both of us also felt that there was enough time to go around and help the groups. It seemed to work well that the students had to formulate and describe in their own words the biology we had tried to teach them. The group work gives us the opportunity to casually go and listen to the students discussing what they have understood and what needs to be clarified: this can be hard to achieve by making them ask questions in class. The more negative sides of this exercise was that it became a bit repetitive, but overall the exercise worked well to wrap up the short course, trying to collect the information given.

Student evaluation of the three types of teaching

In the evaluation only four students had attended all three sessions. Asked which form of teaching style they preferred the structure with lectures and the small exercises was the preference. However they also had comments like:

> "If the two forms (session 1 and 3) could be combined with a 70 % Tuesday (session 1) form and 30 % Monday (session 3) form, that would be best."

For session 3, none of the students prioritized it compared with the others, but the following sentences give indications of deeper learning:

Which one (session type) gave you the best understanding of the subject? Monday (session 3)

> "Difficult to say. At the last one (session 3) we discovered a couple of details, that I hadn't thought about before"

But as one of the students puts it:

> "I think that the proceeds of the teaching depends more on the given exercises and the group than the structure of the teaching. All three forms are good in their own way and to each thing."

Conclusion

This year's teaching was special in several ways, it was the first time the course was divided into a biology part and a programming part, so the students were not quite sure which part of the course they needed the most. We thus found that the students changed between the programming and the biology part during these four sessions, this is of course not the optimum situation when you are planning a continuous biology course, even as small as the one we did. We ended up having a mixture of biologists and bioinformaticians, which was never the purpose of this course. The choice for the students will hopefully be made clearer during the next years of teaching.

In addition to this we, as teachers, also wanted to use these three teaching sessions for this *Adjunktpædagogikum* assignment, thus placing greater demands on the teaching and evaluations. We strongly believe that the course content was not compromised by our additional demands, but that we as teachers were challenged to organize the material into the structure chosen for each of the sessions. In the future we do not have to try all the different lecturing formats but can choose the one we judge most appropriate at each session. We will most likely use a lecture-dominated first session and then shift towards more group work like we did this year. The advantage of activating the students during a session was quite clear to us and if these sessions remain a part of BOHTA, then the effort of making good TLAs is going to be a very good investment.

As mentioned before, this year was the first time the BOHTA course was divided into the first four sessions. Before planning the biology content and teaching style, we had a meeting with the course responsible in order to make sure that we covered the most essential topics of biology for the BOHTA course. We need more feedback from the students and the course-responsible in order to evaluate whether the focus of this years teaching was appropriate. If the students in the coming years are going to be divided more clearly based on their biology and programming background, we might have to change the course content to a lower level and cover a few more topics. The final decision of this will be taken, when we have the final evaluation of the students' overall performance in the course and the

final course evaluation by the students of BOHTA in general, to see if they think anything was lacking in the biology course that they needed later in the course.

We asked the students to fill in the evaluations after each session (see Appendix B) in order to get a better understanding of how the different teaching styles worked for the students learning outcome. The feedback from the students was of very mixed quality and we realize that we need to practise formulating the right kind of questions in order to get enough, relevant information from the students. We of course realize that not all students are going to bother with filling in such questionnaires no matter how much effort we put into it, but we did find that some of the students misunderstood the questions and thus answered with something completely beside the point. This year we had twelve students (at the most) and only four of them took part in all three sessions, so the evaluations are quite sporadic and the comparison of the three different teaching methods lack the significance that we had hoped for.

Some of the students were quite positive about the teaching formats and some were quite opposed to the exercises, this could of course reflect their different backgrounds or that they are more used to the conventional lecture format (Knight & Wood 2005).

In line with asking the right kind of questions, we also learned that we should ask very well structured questions, if we want to guide the students through a longer period of group work. This requires some additional practice in order to find the right balance between letting the students discuss freely in a group and having very structured questions.

In conclusion, this year's biology part of BOHTA was a successful experiment that has increased the biology knowledge of the students as well as giving the teachers some very useful insight into how the different teaching styles work in real situations. In addition, one of the key competences required of a bioinformatician is the ability to work well in groups with several different scientists; we therefore believe that the group work performed in these sessions is suitable to practise this. In addition it is important to learn how to communicate your knowledge both orally and in writing, which we have also tried to implement here. We therefore hope that our short course has done more than just give the students the required biology knowledge.

A Course information from sis.ku.dk – Bioinformatics of high throughput analyses

Udgave:	Forår 2012 NAT
Point:	7,5
Blokstruktur:	4. blok
Skemagruppe:	B
Institutter:	Bioinformatik-centret, Biologisk Institut
Uddannelsesdel:	Kandidat niveau
Kontaktpersoner:	Albin Sandelin albin@binf.ku.dk,
Skema- oplysninger:	Room allocation pending. As a rule, lectures/exercises Mondays 9.30-12, Tuesdays 13-16 and Fridays 9.30-12.
Skema- oplysninger:	Vis skema for kurset Samlet oversigt over tid og sted for alle kurser inden for Lektionsplan for Det Naturvidenskabelige Fakultet Forår 2012 NAT
Undervisnings-form:	Hybrid between lectures and computer exercises.
Formål:	After successfully completing the course, students will master the fundamentals of computational analysis of large biological datasets. This includes both i) understanding the diverse laboratory techniques and biological processes generating the data ii) understanding and mastering the statistical and informatics techniques used for analysis, including the selection of appropriate techniques for a given data and question and iii) interpreting analysis results in a biological context, and identify and apply follow-up analyses based on this. Special focus will be set on the following, both in teaching and evaluation: Extensive hands-on exercises to develop analysis skills; both within lessons and in home work. Analysis – and interpretation - of real biological data sets Realistic problem solving in which finding the exact methods - and the specific R syntax necessary - for attacking a question is an important part of the problem.
Indhold:	There are four major subject areas of the course: 1) Introduction to the program R and applied statistics, and data handling: This will be used throughout the course 2) Visualization, handling and analysis of genomic data using the genome browser, the galaxy tool and R 3) Expression analysis using microarrays and DNA sequencer data (”tag data”) using R and public tools 4) Analysis of proteomics data using R and public tools.
Målbeskrivelse:	To obtain the grade 12: The student must be able to explain the motivation, biological relevance and use of the methods covered in the course. The student must be able to understand and critically assess relevant scientific literature. The student must demonstrate expertise in the tools used in the course.

	The student must be able to suggest which methods and programs to apply for a given biological problem, and to point out problems and difficulties relating to such applications. Analogously, the student must be able to understand the strengths and weaknesses of different biological data types. The student must, with the help of program documentation and lecture material, be able to identify the methods that are appropriate and the syntax necessary for solving problems. The student must be able to after analysis interpret the analysis outcome in a biological setting, and identify and apply relevant follow up-analyses or extensions.
Lærebøger:	Scientific articles and handouts available on the home page (compulsory). We strongly recommend students to acquire ”Introductory Statistics with R” by Peter Dahlgaard (ISBN: 978-038795475)(free in the online university library), as it is a great help during and also after the course, but this is not compulsory.
Tilmelding:	Enrolment at Punkt KU from December 1 to December 10.
Faglige forudsætninger:	Students should have a molecular biology background corresponding to those of students in Bioinformatics or Biomedicine master programs (for instance "Introduction to Molecular Biology and Genetics" in block 1 or a life-science oriented bachelor education). Moreover, a basal statistics course such as "Statistics for Biomedicine" in block 2 is strongly recommended.
Eksamensform:	In order to be allowed to the final exam, the student must have had three smaller written group projects approved. The final exam is an individual larger written end-of-course homework. Students are given 1 week to finish it. 7-grade scale. Internal censor. Re-exam: Written homework as the ordinary exam. The three smaller group home works have to be approved before taking a re-exam.
Eksamen:	Hjemmeopgave udleveres den 11. juni og afleveres den 15. juni 2012. Reeksamen. Hjemmeopgave udleveres den 20. august og afleveres den 24. august 2012.
Bemærkninger:	Max. 65 students; master students from Molecular Biomedicine and Bioinformatics have priority as the course is compulsory for these programs.
Undervisnings-sprog:	Engelsk
Sidst redigeret:	7/11-2011

B Evaluation questionnaires handed out to students at the end of each session

Evaluation of the teaching on Tuesday April 24th 2012

Mention 3 things that you learned today?

a)
b)
c)

How did you experience the structure of the teaching?

Do you feel that the exercises increased your learning outcome enough given the time consumption?

What was the best and what was the worst about the structure of todays teaching?

How did the academic level meet your expectations?

Extra question on the evaluation questionnaire from the third session.

Evaluate the 3 different teaching methods used on this course?
