

## Emnerapport for BIO216 – Toksikologi, våren 2018

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**Om kurset:** BIO216 er et 10 studiepoengs-kurs som skal gi studentene en generell innføring i toksikologi. Kurset omhandler ulike aspekter innen toksikologifaget, og tar for seg emner som historie, absorpsjon, distribusjon og utskilling av fremmedstoffer, biotransformasjon, kreftfremkallende stoffer, organtoksikologi, nevrotoksikologi, næringsmiddeltoksikologi, industriell toksikologi, økotoksikologi, toksisitetstesting, og risikovurdering. BIO216 er sammen med BIO316 obligatoriske kurs i masterprogrammet for miljøtoksikologi på BIO.

Undervisningen i kurset var satt sammen av forelesninger (en dobbeltime i uken), laboratorieoppgave (over to dager), en prosjektoppgave, kollokvieoppgaver, to bedriftsbesøk (Statoil og NIFES/HI), samt en midtsemestereksamen. Laboratorieoppgaven, prosjektoppgaven og midtsemestereksamen er obligatoriske, mens deltakelse på de andre aktivitetene er frivillig. Kurset har også en andel av eksterne forelesere med ekspertise innen ulike deler av toksikologifaget.

I 2018 var karaktersettingen i BIO216 basert på 4 evalueringer; 1 prosjektoppgave i grupper (2 eller 3 studenter i hver gruppe) som fremføres som muntlig presentasjon for klassen (teller 10%), laboratoriejournal (teller 10%), midtsemestereksamen (teller 20%), samt avsluttende skriftlig eksamen (teller 60%). Både midtsemestereksamen og endelig eksamen gis som langsvarsoppgaver. BIO216 har en digital avsluttende eksamen.

**Oppfølging av tidligere emneevalueringer:** I tidligere evalueringer av emnet har studentene gitt tilbakemeldinger på at de oppfatter læreboken som komplisert, tunglest, uoversiktlig, og å gi litt for lite bakgrunnsinformasjon og støtte til det som presenteres på forelesning. Dette semesteret ble læreboken derfor byttet ut til "An introduction to toxicology" (Springer) av Philip C. Burcham. Det har også tidligere blitt gitt tilbakemeldinger fra studentene om at forberedelsene til laboratorieoppgaven ikke er tilstrekkelig grundig slik at studentene ikke føler seg nok forberedt til det som skal utføres på laboratoriet. Det ble dette semesteret i samarbeid med BIOCEED og Teach to Learn (TE2LE)-prosjektet laget en undervisningsvideo om beskriver hvordan laboratorieeksperimentet skal utføres og prinsippene bak metodikk og assays (<https://teach2learn.w.uib.no/category/biolab/bio216-toxicology/>). Både den nye læreboken og undervisningsvideoen beskrives i mer detalj nedenfor.

**Undervisningsmaterieell:** Læreboka foreligger i papirutgave og formidles gjennom Akademia. Tillegglitteratur, forelesningsnotater, samt supplerende litteratur ble gjort tilgjengelig elektronisk som pdf-filer via Canvas/MittUiB.

**Lærebok:** "An introduction to toxicology" (Springer) av Philip C. Burcham. ISBN 978-1-4471-7256-7

**Tillegglitteratur:** Kapittel 10 (Biomarkers) og kapittel 15 (Extrapolating from molecular interactions to consequent effects at the population levels) i Principles of Ecotoxicology, 3. utgåve, av C.H. Walker, S.P. Hopkin, R.M. Sibly, and D.B. Peakall, Taylor & Francis, 2006. AMAP 2009, Arctic Pollution 2009. pp 83

**Forelesningsnotater** : PDF-filer over PPT-presentasjonene til foreleserne ble gjort tilgjengelige for studentene på MittUiB av emneansvarlig.

**Kursstatistikk:** 30 studenter søkte opptak til BIO216. 14 studenter møtte på første forelesning og registrerte seg til eksamen. Karaktefordeling (samlet endelig karakter):

A: 5

B: 5

C: 3

D: 0

E: 0

F: 1 (ikke møtt på avsluttende skriftlig eksamen og ikke gjennomført obligatoriske aktiviteter)

**Undervisnings- og vurderingsformer:** Som i 2017 ble det videreført virkemidler innen aktiv undervisning som ble først introdusert i emnet våren 2016 (se vedlegg). Dette inkluderer blant annet bruk av elektroniske responssystemer (PollEv) for å repetere sentrale elementer fra forelesningene, pair-share avbrudd for å få i gang diskusjoner og øke studentaktiviteten i timene, regneøvelser med felles gjennomgang på tavlen for å øke forståelsen og få alle "med", tematisk gruppearbeid med quiz på slutten av forelesningen, samt utførelsen av et organisert eksperiment i forelesningstiden for å illustrere og praktisk vise toksikologiske prinsipper og metoder hvor studentene selv deltar aktivt.

I BIO216 gis det skriftlige tilbakemeldinger (begrunnelse for karakteren) på prestasjonene til studentene gjennom semesteret. Dette inkluderer gjennomføringen/fremføringen av prosjektoppgaven, labjournalen, samt midtsemstereksamen. Vurderingen i BIO216 er på den måten til dels formativ ved at tilbakemeldingene åpner rom for justering av studentenes arbeidsmetoder og bevissthet for egen læring, samt at detaljnivået som kreves for å score godt i faget blir gjort kjent (f. eks. kan tilbakemeldingen på midtsemstereksamen gir en føring på hva som forventes av en besvarelse til den avsluttende eksamen).

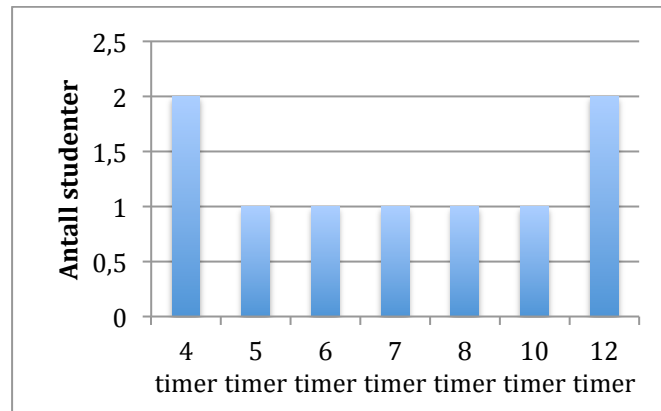
Læringsutbytte til BIO216 (<https://www.uib.no/emne/BIO216>) ble gått gjennom på første forelesning. Undervisningsaktivitetene ble lagt opp for at læringutbyttene skulle oppnås. Per i dag er det ingen krav til forkunnskaper for å ta BIO216, men anbefalte emner blant BIO- og MOL-fag er oppgitt på BIO216 sin emneside hos UiB.

**Rammevilkår:** Tilgang til undervisningsrom, laboratoriefasiliteter og undervisningsassistanse var tilfredsstillende dette semesteret.

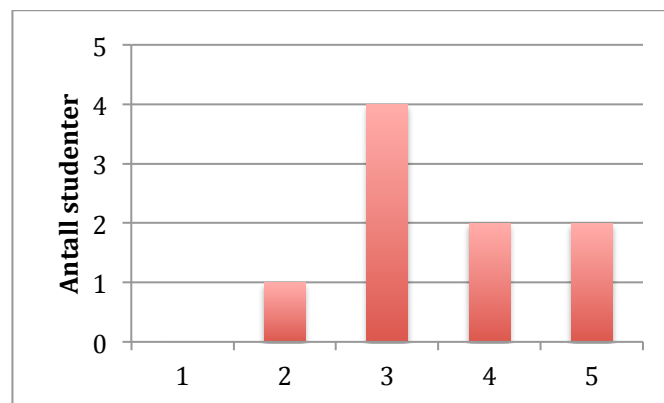
**Studentevalueringer:** Evalueringsskjema av emnet ble delt ut på siste forelesning dette semesteret, samt at det ble sendt ut til studentene på mail slik at de som ikke var tilstede kunne gi sin tilbakemelding. Av 14 studenter som var registrert til eksamen responderte 9 stk. På evalueringen. Evalueringsskjemaet var delt inn i tredeler; **1.** Om studenten; **2.** Evaluering av emnet; **3.** Evaluering av underviser. Det samlede resultatet fra evalueringsskjemaet er gitt under.

## 1. Om studenten

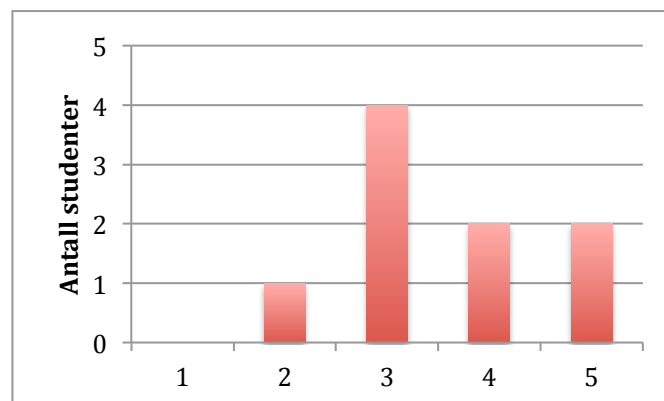
- Er du?
  - Bachelorstudent: 3 stk
  - Masterstudent: 5 stk
  - Annet: 1 integrert master (lektor utdanning)
- Hvor mye gjennomsnittlig arbeidstid *per uke* har du brukt totalt på dette emnet (inkludert forelesninger, gruppeøvelser, lab/felt, egenstudier)?



- Hvor mye teoretisk kunnskap har du tilegnet deg på dette emnet? (1=ingen, 5=me)



- Hvor mye praktisk kunnskap har du tilegnet deg på dette emnet? (1=ingen, 5=me)



## 2. Generell evaluering av emnet

Vurder disse påstandene:

	Veldig uenig	Uenig	Nøytral	Enig	Veldig enig	Vet ikke
<i>Det var tydelige læringsmål for dette emnet</i>	0	0	0	5	4	0
<i>Det faglige innholdet stemte med læringsmålene</i>	0	0	0	2	6	1
<i>Det faglige innholdet var oppdatert og relevant</i>	0	0	0	0	8	1
<i>Det var lagt opp til passe mengde med lesing som egenarbeid i dette emnet</i>	0	0	0	3	5	1
<i>Det var lagt opp til passelig mengde skriving som egenarbeid i dette emnet</i>	0	0	0	3	5	1
<i>Emnet virker viktig for min utdanning</i>	0	0	1	3	5	0

Vurder disse påstandene om pensum:

	Veldig uenig	Uenig	Nøytral	Enig	Veldig enig	Vet ikke
<i>Pensum var aktuelt</i>	0	0	1	4	4	0
<i>Pensum var relevant</i>	0	0	0	4	5	0
<i>Mengden pensum var passelig</i>	0	0	0	5	4	0

- Er du kjent med hva som er eksamensrelevant pesum i emnet?
  - Ja: 9
  - Nei: 0
  - Usikker: 0
- Hvor mye av pensum leste du?
  - Ingenting:
  - Mindre enn halvparten: 2
  - Ca halvparten: 2
  - Mer enn halvparten: 3
  - Alt: 2
- Hvilken karakter vil du gi dette emnet?
  - F:
  - E:
  - D:
  - C:
  - B: 6
  - A: 3

*Hva likte du mest ved emnet? (kommentarer fra studenter)*

- "Det at det ga meg grunnleggende forståelse av hvordan stoffer påvirker kroppen"
- "Bredt og aktuelt innhold om toksiner i dag. Mye bra fra gjesteforeleserne"
- "Praktisk info om arbeidslivet"
- "At det var variert og ulike måter å lære på"
- "Forelesningene og lab"
- "Teorien, forelesningene, kollokvier"
- "Lab-arbeid, midtsemestereksamen, gruppeoppgaven. Mye variert undervisning"
- "Spennende og interessant fag"
- "Likte veldig godt faget. Fikk veldig smak for toksikologi. Kjekt med liten klasse.
- "Spennende å få besøk av ulike "fagfelt" innen toksikologi"
- "Veldig bra! Mye variert arbeid og forelesninger"
- "Skulle gjerne hatt flere kollokvier"
- "Jeg synes at emnet har vært veldig bra. Vi har hatt mange gode måter å lære på slik som fremføring, lab, bedriftsbesøk og gode forelesninger som har vært med på at det er mye man har lært"

*Hva likte du minst ved emnet? (kommentarer fra studenter)*

- "Pensumboka var avansert og veldig mye detaljert"
- "At det var mye å sette seg inn i og mye detaljer som er viktig"
- "Tok litt tid med rettinger"
- "Bredt og detaljert, mye som må læres om mye forskjellig"
- "Mange kjemiske uttrykk og stort krav til forståelse av kjemi"

*Har du forslag til hvordan emnet kan forbedres? (kommentarer fra studenter)*

- "Flere kollokvier og enda mer variasjon i læringen. OA var flinke på dette"
- "Kanskje ikke legge midtsemestereksamen over en helg"
- "Egentlig ikke"

*Evaluerings av praktisk undervisning/øvelser (kommentarer fra studenter)*

- "Lagt opp bra. God kommunikasjon mellom studenter og foreleser/veiledere."
- "Veldig bra – oversiktlig. God introduksjon (PP + video). Flinke assistenter"
- "Har gått fint. Forståelig. Fikk god hjelp"
- "Veldig bra!"
- "Meget bra og interessant"
- "Bra at fokuset ikke var mot lab-teknikker og mer mot det som faktisk ble gjort"
- "Jeg synes den praktiske undervisningen var god"

### 3. Evaluering av underviser(e)

	<i>Aldri</i>	<i>Noen ganger</i>	<i>Som oftest</i>	<i>Mesteparten av tiden</i>	<i>Alltid</i>
<i>Fikk du klare svar på spørsmål du stilte til underviseren?</i>	0	0	0	4	5
<i>Var underviseren hensynsfull ovenfor deg?</i>	0	0	0	4	5
<i>Var undervisningen godt strukturert?</i>	0	0	1	4	4
<i>Viste underviseren engasjement for undervisningen?</i>	0	0	1	1	7
<i>Var underviseren en god formidler?</i>	0	0	1	3	5

#### *Kommentarer:*

- "Flink. Engasjert. Lyttande"

- "OA var den mest varierte og dermed best. De besøkende kunne vært mer aktive med oss, ble lit mye avlesning av powerpoint"

- "Jeg er svært fornøyd med underviser"

*Har du forslag til hvordan underviserne kan forbedre sin undervisning? (kommentarer fra studenter)*

- "Nei, fortsett slik du gjorde det"

- "Stille mer spørsmål underveis. Mer quiz. 15 min på slutten forelesningene. Oppsummering"

- "Ha flere varierte aktiviteter. Quiz var amazing"

- "Bittelitt mer engasjement, men er ganske engasjert til forskjell fra resten av foreleserne på mol"

- "Ingen ting konkret. Ganske fornøyd"

**Kommentar:** I all hovedsak virker studentene å være godt fornøyd med gjennomføringen av BIO216. Fra studentevalueringen fremgår det at de aller fleste synes at kurset er faglig interessant og spennende, og at studentene setter pris på variasjonen i form av de ulike kursaktivitetene. Selv med en rekke ulike aktiviteter gjennom semesteret, betrakter studentene arbeidsmengden som tilfredsstillende og at det er en god struktur på kurset. Det kom opp et ønske om enda flere kollokvier og økt bruk av aktiv læring, som f. eks. Quizer i slutten av hver forelesning. Dette er absolutt noe som kan vurderes frem mot neste gang emnet skal undervises. Generelt scorer foreleserne godt når det gjelder tilbakemelding fra studentene, og det er også en positiv tilbakemelding når det gjelder å hente inn eksterne forelesere med spesifikk kompetanse. Med unntak av en kommentar, ble det ikke uttrykt noen misnøye ovenfor den nye læreboken fra studentenes side. Noen studenter tar opp at det er mange detaljer som må læres og forstås, samt at en viss bakgrunn i kjemi fra tidligere er fordelaktig. Majoriteten av studentene ser imidlertid ikke ut til å ha noen problem med dette. Det kan vurderes om man bør ha kjemi/biologi/mol som krav til forkunnskaper for å kunne ta emnet.

Fra studentevalueringen virker det også å være generell oppfatning om at det er et godt samsvar mellom innholdet i kurset og det som uttales som læringsmål og læringsutbytte.

**Vurdering av lærebok:** "An introduction to toxicology" (Springer) av Philip C. Burcham, ble forsøkt for første gang som lærebok i BIO216 dette semesteret. Boken er relativt lettlest og forklarer deler av toksikologifaget på god og enkel måte for nybegynnere. I forhold til den forrige læreboken er den største innvendingen at den ikke omhandler like mange temaer innen toksikologi, også temaer som er viktige og som er, og bør, være en del av pensum. Noe tilleggslitteratur i form av kapitler fra den gamle boken ble derfor gjort tilgjengelig på MittUiB og gått igjennom i mer detalj på forelesninger. Dette var spesielt aktuelt i forbindelse med enkelte av gjesteforeleserne hvor deres tematikk ikke ble dekket godt nok i den nye læreboka. Læreboka fremstår foreløpig derfor ikke som helt fullgodt alternativ som alenepensum, men den fungerer sammen med støttelitteratur. Denne læreboka blir derfor videreført i BIO216 fremover, men egnede alternative lærebøker vil også vurderes ved anledning.

**Video i undervisningen:** I tidligere evalueringer av BIO216 har studentene gitt tilbakemelding på at de ønsket å stille enda bedre forberedt til laboratoriekurset. Det har tidligere i forkant av selve laboratorieoppgaven blitt gitt en egen kort presentasjon av bakgrunn, metoder og prinsipper bak forsøkene. Det er tidligere vist at uforberedte studenter ikke lærer så mye som de burde fra feltarbeid og laboratoriekurs dersom de stiller uforberedt. Samtidig kan undervisningsvideoer gjøre at foreleser unngår å måtte forklare det samme gjentatte ganger til forskjellige studenter. Dette semesteret ble det i tillegg til en felles gjennomgang i forkant av laboratorieøvelsen i samarbeid med TE2LE (BIOCEED) laget en video som detaljert beskriver og demonstrerer forsøkene studentene skal utføre og forklarer samtidig prinsippene bak observasjonene som skal gjøres (<https://teach2learn.w.uib.no/category/biolab/bio216-toxicology/>). Studentene ble pålagt å se videoen før labkurset, og måtte via MittUiB svare på noen spørsmål fra videoen for å bekrefte at dette var gjort. Den umiddelbare tilbakemeldingen fra studentene indikerer at dette var vellykket og informativt, og var til hjelp for studentene til å forberede seg til undervisningen. En grundigere undersøkelse av effekten av bruk av video i BIO216 undervisningen ble gjort av Anne-Laure Simonelli (BIOCEED) og skal inngå i en publikasjon, men de endelige resultatene fra disse undersøkelsene foreligger ikke da denne emneevalueringen ble skrevet.

**Samlet vurdering:** I all hovedsak virker studentene fornøyd med gjennomføringen av BIO216 våren 2018. Virkemidler innen aktiv undervisning som ble introdusert tidligere ble videreført dette semesteret, i tillegg til at bruk av video ble utprøvd i undervisningen i forbindelse med forberedelsene til laboratoriekurset. De foreløpige tilbakemeldingene fra studentene tyder på at dette var til god hjelp, og vil videreføres neste semester. En mer detaljert undersøkelse av effekten av dette vil bli vurdert og presentert i en egen undersøkelse (Anne-Laure Simonelli). Skifte av lærebok virker å bli tatt godt imot fra studentene sin side, men siden den har noen mangler i forhold til hva som er pensum holdes muligheten åpen for å gjøre forandringer på læreboken også i fremtiden. Dette for å unngå for mye bruk av tilleggspensum. Det nåværende undervisningsopplegget for BIO216 vil bli videreført i 2019. Det vil imidlertid bli vurdert om enda flere elementer av aktiv undervisning skal introduseres i kurset, blant annet mer utstrakt bruk digitale responssystemer for oppsummere og trekke sammen viktige deler av pensum, samt å fremme mer diskusjoner omkring relevante temaer i klasserommet.

Odd André Karlsen, førsteamanuensis  
Emneansvarlig

# Introducing active learning strategies in toxicology teaching

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## *1. Introduction*

In the traditional lecture, the students are passive receivers of information that is communicated by the lecturer (Walczyk and Ramsey 2003). However, accumulating evidence from the last decades of pedagogical research strongly suggest that this classical approach for learning is not very effective and do not stimulate for deeper learning and understanding (Felder, Woods et al. 2000, Prince 2004, Michael 2006). On the other hand, by introducing active learning strategies into the classroom where the students themselves are engaged in the learning process during class time, it has been shown that the retention of the material increases, the students become more motivated, and develop their skills in both thinking and writing (Freeman, Eddy et al. 2014). Furthermore, when a student catches interest in a subject, it is likely that this promotes self-motivation and self-regulation. When this is combined with the ability to be proactive and reflective, the student is also more likely to acquire deep knowledge and develop advanced analytical skills.

Although the term “active learning” is interpreted differently in the literature, it is in general defined as an instructional approach that both includes and engages students in the learning process (Bonwell and Eison 1991). This includes the introduction of activities such as class discussions, think-pair-share discussions, “clicker questions”, problem-based learning, peer-learning, and Socratic dialog, but does not refer to traditional activities like homework (Lyman 1992, Crouch and Mazur 2001, Bruff 2009).

BIO216 is a 10-credit toxicology course lectured at the University of Bergen (<http://www.uib.no/emne/BIO216>). It encompasses several aspects regarding toxicology, such as historical perspectives, absorption, distribution, and secretion of toxic compounds, biotransformation of xenobiotics, toxicant induced carcinogenesis, organ toxicology, toxicity testing, and risk assessment. The course includes various learning activities besides lecturing, including a lab course, colloquiums, graded project assignments with oral presentations, and company visits.



However, the lectures have traditionally been given in a conventional approach, i.e. the students are passive recipients of information. In order to promote an active learning environment and stimulate to student engagement and deeper learning also in the classroom, several active learning strategies were explored during the spring semester 2016. This report describes the learning activities that were introduced, and present reflections from the lecturer upon the experiences from these activities in light of student responses obtained from a questionnaire after the course ended.

## *2. Class setting and active learning strategies*

BIO216 is usually lectured in a rather small class with a typical number of students between 10 and 25. It is assumed that active learning is particularly beneficial for small classes, and BIO216 should therefore be a well-suited course for implementing active learning strategies (Freeman, Eddy et al. 2014). In the spring semester 2016, 19 students were signed up for the course. The educational backgrounds of the students were mixed, but most of them were bachelor students in biology, molecular biology, pharmacology, or nano-technology, with no or very little experience within the field of toxicology. The active learning activities that were introduced in BIO216 were think-pair-share discussions, use of digital response systems, a collective

calculation exercise during class, thematic groupwork with oral presentations, and an organized lab-experiment during classroom teaching for illustrating toxicological principles.

### *2.1 Think-pair-share discussions*

Lyman introduced think-pair-share as an active cooperative learning technique in 1981 (Lyman 1981). It is a three-step process where in the first step the students individually, and for a limited amount of time, reflect about a question or problem given by the lecturer. After organizing their thoughts, they move on to the next step where they discuss their answers in pairs. In the final step, the students share their answers with the whole class. This learning technique gives the students the opportunity to identify what they know and, importantly, what they do not know. Furthermore, it stimulates to interaction between the lecturer and the students, and the students can reflect on their own ideas in a very active manner. Working in pairs can also reduce stress and anxiety students may have when it comes to answering questions posed by the lecturer (Wichadee 2010). An example of a think-pair-share question that was used in the BIO216 course is: "What is the endocrine system, and how does an endocrine disruptor act?"

### *2.2 Digital response systems*

Electronic response systems are technology that promotes and implement active

learning by interactivity (Bruff 2009). More specifically, it is software and hardware systems that provide an interface where students can submit answers to questions via a transmitter, such as a smartphone or a laptop, or a dedicated “clicker”. It allows students to anonymously commit to instructor-posed questions during class, and provides immediate feedback to both the instructor and the students. Several reports suggest that electronic response systems promote a more dynamic and interactive classroom, and importantly, may stimulate to an increase in student attendance, participation, and learning outcome (Fies and Marshall 2006, Caldwell 2007). One version of electronic response systems is Poll Everywhere, which has a free-to-use open license for up to 25 responses per poll that is created. Poll Everywhere was used in an integrated manner with PowerPoint, and students used their smartphones for answering the polls. Usually, such systems are implemented in larger classes than BIO216, but also positive results in smaller classrooms have been documented (Draper 2002). Multiple-choice polls for emphasizing important parts of the curriculum were used frequently throughout the semester, and each poll included 5 to 10 questions.

### *2.3 Exercises during the class (individual exercise)*

Another mean of active learning that was introduced, was a calculation exercise given

to the students during class. This exercise was part of the curriculum that dealt with toxicokinetics, and specifically, different calculations should be performed around an example where a person had consumed a significant amount of windshield washer fluid. The students were left to work with the different calculations individually, and provided sufficient time to reflect about the questions and attempt to identify the approach to solve them. Some clues and necessary mathematical formulas used in toxicokinetics were provided on a slide together with the exercise, and the students were allowed to ask questions when struggling or needing some hints to move on. After approximately 30 minutes, the exercises were solved on the blackboard in plenary and the students were encouraged to volunteer (no one was forced) to come up and demonstrate their approach for reaching their answers. It is assumed that the act of solving exercises forces students to engage and learn the material, and by going through the exercises together, it increases the chance for the students to absorb the curriculum and possibly obtain a more comprehensive understanding of the material presented in the lecture.

### *2.4. Group work with presentations (cooperative learning)*

Group work can be an effective method to motivate students, encourage active learning, and develop their skills in critical-thinking, communication, and decision-

making (Jaques 2000). Furthermore, through peer-instruction, students are able to teach each other by clarifying misconceptions and addressing misunderstandings. Students were in this case randomly put together in groups consisting of three students per group. The groups were then given different subjects within organ toxicology, such as toxicology of the heart, the kidneys, the liver, and so on. The group's tasks were to find information covering some specific areas within their assigned organ, such as cell types, toxicants, and toxicological responses. These keywords were given by the lecturer and should be specifically addressed by the groups. After working in groups in the first half of the lecture, all groups presented their findings as a PowerPoint presentation to the class during the second half of the lecture.

### *2.5. Classroom experiments*

Classroom experiments are activities where students work in groups, or individually, and collect data through interaction with typical laboratory materials and data simulation tools, combined with a series of questions that lead to discovery-based learning. In contrast to a classroom demonstration, the students themselves are involved in collecting data or observations. Classroom experiments can help the students learn more about the material they are studying by testing hypothesis derived from the material contained in the course curriculum (Farrell, Moog et al. 1999). The

lecturer can act as a facilitator by asking leading questions and draw attention to interesting results, but it is important that the students make their own predictions and reflect upon their observations. In the BIO216 course, an imaginary situation within ecotoxicology was made up by the lecturer, but communicated to the students as a true case. The case was as follows: Male Atlantic cods were recently sampled from different locations in the Bergen area, i.e. from Store Lungegårdsvann, Øygarden, and Askøy. Store Lungegårdsvann is a highly polluted area containing quite large amounts of legacy contaminants, such as PCBs. Øygarden is considered to be far less polluted, and may be considered as a reference site. The fish sampled from Askøy were caught close to a sewage drain. The research-question was if the fish that were caught in these locations were exposed to pollutants that acted as endocrine disruptors. To answer this, students were divided into groups, and pipettes, tubes with cod plasma, and a "dipstick" (almost like a pregnancy test) were handed out. The "dipstick" is used for detecting the presence of a protein called vitellogenin in fish plasma. Vitellogenin is normally not present in male fish, but when exposed to estrogenic compounds (endocrine disruptors), the production of vitellogenin can be initiated through activation of the estrogen receptor, leading to egg production and feminization in males, which can have devastating effect on fish populations. Before the practical

part of the exercise was performed, the students were given time to make predictions of what they expected to find based on the locations for fish sampling. The results and observations made by the different groups were discussed in plenary, and the molecular mechanisms and principles behind their observations were described in detail.

### *3. Reflections on the experience with active learning strategies*

After the BIO216 course ended in spring 2016, a web survey about the course (course evaluation) was emailed to the attending students. Several questions regarding the active learning strategies were included in the survey, and some of the reflections made by the students, and the lecturer, are presented here. Of 19 students that followed the course, 9 students responded to the web survey (the full version of the course evaluation can be found at (<https://kvalitetsbasen.app.uib.no>)).

#### *3.1 Think-pair-share discussions*

Eight out of nine students responded that their engagement increased during the lecture with the think-pair-share activity. Two of the students also commented that they prefer the discussion with another student before answering, avoiding the anxiety that can occur when the lecturer points directly at someone. This is also in agreement with other reports stating that cooperative learning approaches can reduce

learning anxiety (Wichadee 2010). Five of the students also reported that this activity increased their learning outcome, where one of these students emphasized that the best way to learn is to discuss the curriculum with others, because then you have to structure and express the material yourself. As the lecturer, I enjoyed this activity because it was a very nice tool for making the students talk, both to fellow students and to the lecturer. It has previously been reviewed in the literature that cooperative learning promotes a friendly teaching/learning atmosphere, which I think also was the case for this course (Johnson, Johnson et al. 1998). Think-pair-share discussions worked also as a nice break during the lecture, and with the correct questions it is possible to emphasize important parts of the curriculum, and with easy means engage the students in the material that is lectured.

#### *3.2 Digital-response systems*

Nine out of nine students answered that their engagement and activity increased with the use of Poll Everywhere. However, only four of the students thought that this activity increased their learning. Possible reasons for this, which also was pointed out by some of the students, may be related to distractions resulting from some technical issues and that the correct answers to the quizzes were not sufficiently explained. It was also mentioned in the survey that in such a small class as in the BIO216 course, it

could be more beneficial to rather have open discussions covering the same questions as presented in the quiz. This is a good point, but it is also possible to couple digital-response technology to other active learning approaches, such as classroom experiments or cooperative learning, providing many opportunities for combining teaching pedagogies. Among the positive experiences noted by the students was that the curriculum is memorized well when you are allowed to reflect upon different questions. Importantly, the course evaluation provided constructive feedback from the students that may help to improve the learning outcome when using digital response systems. One of these suggestions was to further extend the use of such systems and present a quiz in every lecture that repeat, refresh, and emphasize the most important parts of the curriculum.

### *3.3 Calculation exercise*

The majority of the students replied that the calculation exercise performed during the lecture improved both their activity and their learning outcome. There was also positive feedback regarding this exercise since it demonstrated the use of mathematics in toxicology and how mathematics can be used to something useful (as expressed by a student). One of the students commented that he/she would have appreciated more time for solving the exercises. One alternative would be to hand out the exercises beforehand so the

students have more time to prepare for this activity. Furthermore, the lecturer noticed some reluctance among students in volunteering to demonstrate how they solved the exercise in front of the other students. To reduce the anxiety, maybe it would be better to promote a cooperative learning situation by organizing the students into pairs and make the students explain their strategies to each other. The session can be ended with the lecturer going through the exercises on the blackboard with input and suggestions from the students.

### *3.4 Group work with presentations*

Near all students responded that the group work increased their activity in the lecture. However, only 50% of the students that responded to the survey replied that this activity increased their learning outcome. Notably, group work was the exercise where this lecturer was least satisfied with the implementation of the active learning activity. The activity could probably be significantly improved by e.g. being more specific about what type of information that should be gathered and presented to the other students. This can be achieved by preparing an even more detailed template for the student presentations, assuring that the essential parts of the curriculum are covered. It may also be beneficial to hand out the group exercise in some time beforehand, so the students have more time to research information and prepare more

informative presentations. Some of the students also reported that they struggled to comprehend the other student presentations, and that many students appeared to be more focused on working with their own presentation rather than listening to the others. However, numerous reports exist where the benefits of cooperative learning have been demonstrated, especially with regard to reasoning and critical thinking skills (Johnson and Johnson 1989). Thus, more careful design of this activity could possibly enhance its usability in the BIO216 course. Among the positive feedbacks was that this activity was a good arena for practicing presentation skills.

### *3.5 Classroom experiment*

As reflected in the course survey, the students appreciated and welcomed the practical experiment that was performed during class. All students were activated, and everyone reported that the exercise increased their learning outcome (while having fun at the same time). This activity can be categorized as learning by doing, and the impression is that this practical exercise significantly enhanced the students' willingness to learn and increased their understanding of how biomarkers can be used to trace effects of environmental pollutants. However, the lecturer made one mistake during this exercise. Never(!) unveil for the students that the story and the exercise they were introduced to were just a

fabrication (preferably not even after the exercise is finished). Their engagement persists much longer when they strongly believe that they have contributed to an important discovery.

### *4. Concluding remarks*

This was the first time this author introduced active learning strategies in classroom teaching of toxicology. Different activities were implemented, including think-pair-share discussions, use of digital response systems, a calculation exercise during class, thematic group work with oral presentations, and an organized lab-experiment during classroom teaching. As revealed by the course survey, the overall response from the students in this course was very positive. Students appreciated the variety in how the curriculum was lectured and reported that the introduced activities increased their participation and their activity during the lectures. Furthermore, the impression of the lecturer is that the added engagement during class also increased their motivation to learn, which should facilitate higher learning, better retention of the material, and the development of advanced analytical skills. Among the different activities that were tested, especially the think-pair-share and the classroom experiment stand out as valuable tools for both activating and motivating the students in a small class. Active learning strategies will be further developed and used in future toxicology

teaching in BIO216. In this regard, the fashion for obtaining the student's evaluations of the different learning activities must be reconsidered. The student responses presented in this report are based on a questionnaire that was distributed to the students after the course had ended. Only 50% of the students responded to this survey, which of course could introduce a bias when assessing such evaluations. A possible approach could be to organize separate evaluations of the different activities at the end of each lecture (or in the beginning of the next lecture) to assure that as many students as possible respond to the survey, also while they still have in mind a clear impression of the activity as well.

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