Enhancing students' awareness of future relevance of basal toxicology – is the learning outcome improved?

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Introduction

The Veterinary Pharmacology and Toxicology (VPT) course is a 15 ECTS bachelor course which is given in the 2nd year during the Veterinary education (see **appendix A** for the VPT course description). Approximately 180 students follow the course, which primarily consists of lectures of approximately 3 x 40 min. The course is divided into six modules of which module 6 focuses on veterinary toxicology. Module 6 is separated into basic toxicology and clinical toxicology. The basic toxicology consists of two lectures which focus on introducing the student to toxicological test methods and procedures used in drug development in the medical industry as well as veterinary relevant concepts related to food safety such as Maximum Residue Levels (MRLs) [the highest level of a compound residue that is legally tolerated in or on food or feed.] and retention time [the time period from an animal is medically treated until the animal or products thereof may be used for consumption].

In the author' opinion, the VPT course follow a constructive alignment (Biggs 1996; Biggs and Tang 2007) where the Intended Learning Outcomes (ILOs), the Teaching/Learning Activities (TLAs) and the exam are well aligned. However, last year I taught the veterinary students basal toxicology for the first time, but despite my perception of a well-structured course, I found that the students were struggling at the written exam. In fact, only approximately half of the students (92 out of 183 students, 50.3%) were able to answer more than half of the questions correctly within basal toxicology. The working hypothesis for this project

was that the students found the subjects in basal toxicology less relevant for their future careers as veterinary clinicians, hence were not motivated and therefore did not prioritize to learn the subjects. According to the model of learning by Illeris, 2016, there are three dimensions (i.e. content, incentive and environment) and two processes (i.e. acquisition and interaction). I therefore aimed at focusing on the dimension student' "incentive" to obtain a deeper understanding of the student' motivation or lack of motivation to learn basal toxicology. In addition, I sought to enhance the students' motivation for learning the subjects. Hence, a framework was implemented in the teaching that aimed at explaining the relevance of the subjects. The objective was to drive the students towards a more *self-determined extrinsic motivation* where they could *identify* the importance of the subjects for their future career or optimally drive the students towards an *intrinsic motivation* (Ryan and Deci 2000). The rationale behind was, that if the students recognized the relevance of the teaching, a goal-oriented approach where the students **want** to understand the concepts and the ILOs, (i.e. *mastery goals* approach) could be used (Cook & Artino, 2016).

Objective, implementation of the intervention and evaluation

The overall objective was to improve the learning outcome for the veterinary students in basal toxicology, by implementing the interventions described below. The aims (A) of the interventions were to:

A1 understand the students' motivation or lack of motivation to learn basal toxicology

A2 motivate the student to want to learn about basal toxicology

A3 obtain students' evaluation of basal toxicology

A4 evaluate the exam outcome in comparison to the previous year

This was accomplished by the following interventions. **A1**: First, the students were encouraged to reflect on why they should learn basal

toxicology. This was performed in the beginning of the first lecture using two open-ended questions which are given below.

How do you perceive the subject toxicology?

Why do you think that you, as a future veterinarian, need to know about toxicology?

The students were given 3 minutes to discuss these questions, and were subsequently asked to provide a few key words in Sendsteps, describing their perception. **A2**: To motivate the students, a goal-oriented approach was used by including a list of potential future work areas, where knowledge of toxicology is required. This was performed with an attempt to highlight the relevance of basic toxicology in relation to potential future work areas. The work areas included were: 1) the clinic (i.e. intoxicated animals); 2) the medical industry with emphasis on **drug development** in human and veterinary medicine: 3) **food safety** with emphasis on the fact that many veterinarians find job position in the Danish Veterinary and Food Administration (FVST) and 4) **environmental toxicology** including substances such as per- and polyfluoroalkyl substances (*PFAS*). Clinical toxicology was mentioned but not covered in basal toxicology. The lectures in basal toxicology were restructured and build around the latter three potential work areas. The presentations included: the ILOs, theoretical description of the concepts, videos explaining additional concepts, multiple choice question (MCQ) quizzes related to some of the ILOs, detailed description of specific toxicological tests, examples of real-life projects or environmental toxicological challenges, introduction of guidelines for drug development in both human and veterinary medicine and assignments related to the various subjects. The quizzes were used during the lectures approximately every 35 min. The aim was to provide the students some time to reflect what have just been taught. At the end of each lecture the students were given approximately half an hour to solve assignments in groups, whereafter the answers were discussed in plenum. Some of the assignments were previous exam questions which were used to prepare the students for the type of questions they could be presented for at the exam. **A3**: At the end of the second lecture, the basal toxicology was

evaluated using MCQs in Sendsteps and included the following questions (*Q*):

Qa) Did the lectures in basal toxicology provide you with an overview of why you as a future veterinarian should have a basic understanding of toxicology?

Qb) Do you find the ILOs relevant in relation to the work areas veterinarians may take?

Qc) Have the concepts and the ILOs for the basal toxicology been explained sufficiently?

Qd) In which area do you expect to find your future position?

In addition, the students were encouraged to provide specific suggestions in Sendsteps for improving the teaching in basal toxicology. The purpose of these comments was to use them as a guideline for improving the teaching the following year. **A4:** The written exam, which is a 4-hour examination without any books etc. was used to evaluate whether the concepts of food safety were taught in a better manner this year in comparison to the previous year. The exam questions in basal toxicology from summer 2022 and 2023 were similar, and both formulated to reveal if the students understood the concept of food safety in relation to medical residues in food producing animals. It was considered a successful outcome if 50% or more of the answers to basal toxicology were correct.

Results

Twenty-three students out of approximately 130 students answered the question "*Why do you think that you, as a future veterinarian, need to know about toxicology?*" (see **appendix B** for the answers of the students. The answers are given in Danish as the course is held in Danish). A total of 16 out of 23 answers, were related to clinical toxicology, whereas 3 were associated to basal toxicology and 4 answers considered vague and therefore categorized under "Answers related to other subjects". Although relatively few students answered the question: "*Why do you think that you, as a future veterinarian, need to know about toxicology?*"

it provided some insight into what the students perceived as basal toxicology. Most answers were focused on how toxicology could be applied in the clinic. Thus, to highlight the relevance of basic toxicology subject, *in vitro* and *in vivo* toxicological tests used in **drug development**, concept related to **food safety** and risk analysis related to **environmental toxicology** were taught during the lectures and sought to be placed into the three different work areas. The MCQs evaluation of the course is provided in **figure 1a-1d** and show the number of students that selected the predefined answers. The number of students participated in the evaluation varied from 47 to 122 between the questions asked. Approximately half (46.8%) of the students that answered *Qa* (*n*=47) found that the lectures provided them with a clear overview of why they as future veterinarians should have a basic understanding of toxicology. The other half (46.8%) found it less clear and believed the lectures were too detailed (**fig. 1a**). Fifty percent of the students that answered *Qb* (*n*=76) found the ILOs partly relevant, whereas 48.7% perceived the ILOs as highly relevant. Only a single student did not find the ILOs relevant at all (**fig 1b**). A majority (59.5%) of the students that answered *Qc* (*n*=79) found that the concepts and the ILOs were explained sufficiently, whereas 30.4% found that the concepts and ILOs were partly explained. Five students (6.3%) did not know, and 3 students (3.8%) were not satisfied (**fig. 1c**). Most students answered *Qd* (*n*=122). Not surprisingly, a majority of the students (68.8%) expected to work with either small animals, horses or livestock in the future. However, 13.9% of the students saw themselves in the medical industry, 4.1% of the students were considering FVST, 9.8% were considering other areas and 3.3% was undetermined (**fig. 1d**). Additional comments and suggestions from the students are provided in **appendix C**. In general, the students requested more structure and a slower pace during the lectures and 6, out of 43 comments (13%) were related to the exam. These 6 comments are underlined in appendix C.

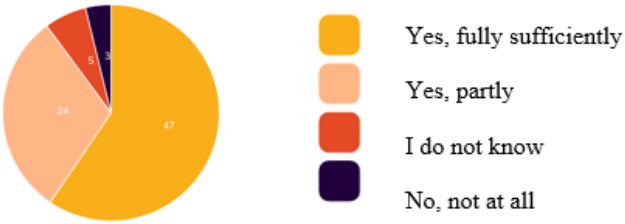
The students' answers to the exam questions in basal toxicology were evaluated, and 149 out of 161 students (92.4%) were able to provide answers that were at least 50% correct (data not shown, confidential). Thus, for this year' teaching, more students were able to answer the

question in basal toxicology in comparison to the previous year where only 50.3% of the students were able to achieve this.

1a

1b

1c



1d

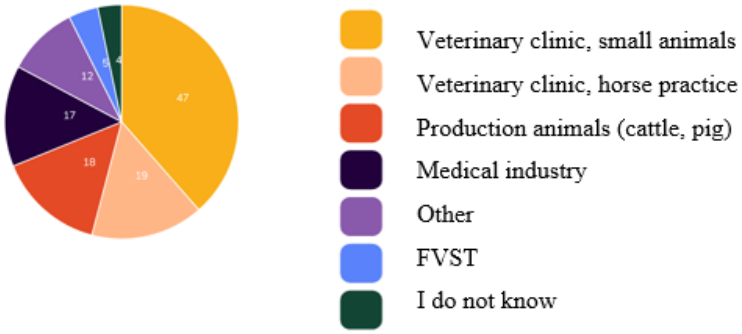


Fig. 1a-d. Evaluation of basal toxicology. The students' answers to question a-d (Qa-Qd) are given in **fig. 1a**: (*n*=47), **fig. 1b**: (*n*=76), **fig. 1c**: (*n*=79) and **fig. 1d**: (*n*=122), respectively. The questions were as followed: Qa) Did the lectures in basal toxicology provide you with an overview of why you as a future veterinarian should have a basic understanding of toxicology? Qb) Do you find the ILOs relevant in relation to the work areas veterinarians may take? Qc) Have the concepts and the ILOs for the basal toxicology been explained sufficiently? Qd) In which area do you expect to find your future position?

Assessment of and reflection on the interventions

The overall objective of the intervention was to improve the learning outcome for the veterinary students in basal toxicology. This was tried accomplished by achieving a better understanding of the students' motivation or lack of motivation, placing the subjects into work-related scenarios by restructuring the lectures, obtaining an evaluation of basal toxicology from the students and compare the exam results from this year with the previous year.

In general, a majority of the students that answered the questions found that the lectures provided them with a clear or partly clear overview of why they should have a basic understanding of toxicology (**fig. 1a**). Most of the students found the ILOs relevant or partly relevant (**fig. 1b**) and that the concepts and ILOs were explained in a fully or partly sufficient manner (**fig. 1c**). The results from the exam showed a considerable improvement compared to the previous year. The improvement shows that this year' teaching was more successful in relation to the exam, and perhaps due to an altered perception of basal toxicology of the students. Whether the individual student has a *performance-goal* approach, in which the student learn the ILOs and concepts to avoid failure or a *mastery-goal* approach, in which the student actually **want** to acquire new knowledge and skills (Cook and Artino 2016) is not known from this intervention. However, the additional comments and suggestions from the students (**appendix C**), gave some insight into the students' opinion of the teaching. From these, it can be deduced that several students desired more structure and a slower pace of teaching and that the exam was of major importance. In addition, several students appreciated the MCQ quizzes, videos, "real world" examples

and the lectures. Thus, more of these could be included in the lectures to increase the variation in the teaching.

The number of students who participated in the intervention varied between the questions asked. Thus, it is likely that the evaluation of the lectures would have been different if all the students had participated. Particularly it is uncertain whether a majority of the students associated the subject basal toxicology to clinical toxicology, as only 23 students answered the question "*Why do you think that you, as a future veterinarian, need to know about toxicology?*" Perhaps, more students would participate if the question was asked in the framework of a MCQ, but in the authors opinion, this would exclude the students own phrasing and thereby important information could be lost.

Outcome of report discussion

The report was read and discussed with a colleague who appreciated the focus on "relevance", "student' motivation" and the initiative to improve students' learning outcome. The course is limited by the time available for teaching in relation to the increasing amount of knowledge within toxicology. To emphasize the relevance, and motivate the students even more, we therefore consider narrowing down the subjects and use novel, relevant research articles as reading material instead of our current textbook that we find highly relevant, but perhaps too broad.

Conclusion and future perspective

The overall objective of the intervention was to improve the learning outcome for the veterinary students in basal toxicology. The improved exam results for this year' question in basal toxicology, suggest that the interventions have improved the learning outcome. However, it is clear from the students' comments that the lectures can be developed further. It will most likely be a future challenge to motivate the students to learn basal toxicology, but in comparison to last year, more students stayed for the discussions at the end of the lectures. This could imply that the students were more motivated this year, perhaps due to the interventions. Next year, it could therefore be interesting to ask the students what they gained from the discussions. From this year' experience it seems that an

increased focus on the utility of the knowledge have incentivized the students. In future perspective, this could be developed further for example by implementing "real-life" cases provided by relevant authorities such as the FVST or by the medical industry.

References

Biggs, John. 1996. 'Enhancing Teaching through Constructive Alignment'. *Higher Education* 32(3):347–664.

Biggs, John;, and Catherine Tang. 2007. 'Using Constructive Alignment in Outcomes-Based Teaching and Learning'. Pp. 50–63 in *Teaching for quality learning at university*. Open University Press, Maidenhead.

Cook, David A., and Anthony R. Artino. 2016. 'Motivation to Learn: An Overview of Contemporary Theories'. *Medical Education* 50(10):997–1014. doi: 10.1111/MEDU.13074.

Illeris, Knud. 2016. 'How We Learn: Learning and Non-Learning in School and beyond: Second Edition'. *How We Learn: Learning and Non-Learning in School and Beyond: Second Edition* 1–272. doi: 10.4324/9781315537382/LEARN-KNUD-ILLERIS.

Ryan, Richard M., and Edward L. Deci. 2000. 'Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions'. *Contemporary Educational Psychology* 25(1):54–67. doi: 10.1006/CEPS.1999.1020.

Appendix A

University of Copenhagen - Courses

SVEB13018U Veterinær farmakologi og toksikologi

Årgang 2023/2024

FOLD ALLE UD

Engelsk titel

Veterinary Pharmacology and Toxicology

Uddannelse

Bacheloruddannelsen i veterinærmedicin - obligatorisk

Kursusindhold

Kurset er opdelt i 6 teoretiske moduler samt et praktisk øvelsesmodul tilhørende Forsøgsdyrskundskab:

Modul 1: Farmaci og basal farmakologi

Farmaci angår lægemidelformer, bestemmelser for rekvirering og distribution af veterinære lægemidler og receptskrivning. Basal farmakologi, herunder farmakokinetik, angår absorption, fordeling, metabolisme, ekskretion af lægemidler, compartment modeller, beregning af dosisregimer samt farmakodynamik inklusiv dosis/virkningsrelationer og receptordynamik.

Modul 2-5: Klinisk farmakologi

Modulerne gennemgår de væsentligste lægemidler, der anvendes i veterinærklinikken. Fokus er på deres virkningsmekanismer, rationel dosering og evt. anvendelse sammen med andre lægemidler. Lægemidlerne omfatter primært midler som anvendes til produktionsdyr og kæledyr ved:

- Bedøvelse
- Beroligelse
- Smertelindring
- Kredsløbslidelser
- Metaboliske sygdomme
- Infektionssygdomme
- Parastitsygdomme

Modul 6: Toksikologi

Modulet introducerer de vigtigste grupper af toksiske forbindelser af relevans for veterinære forgiftninger. Fokus er på deres oprindelse, forekomst og toksiske effekter. Meanismerne bag hyppigste årsager til forgiftning af produktionsdyr og familiedyr gennemgås, herunder diagnostik og behandling. Endvidere introduceres til toksikologiske testmetoder og til baggrunden for beregning af acceptabel daglig indtagelse (ADI) samt maksimale grænseværdier (MRL) for kemiske forbindelser i levnedsmidler. Principper for opstilling af relevante toksikologiske risikoanalyser gennemgås også.

Praktisk øvelsesmodul:

Modulet omfatter praktisk brug af lægemidler, herunder principperne for forskellige injektionsteknikker samt blodprøvetagning, samt håndtering og eutanasi af forsøgsdyr. Procedurerne trænes på bedøvede mus og rotter.

Målbeskrivelser

Efter endt kursus forventes den studerende at kunne:

Viden:

- beskrive relevante farmakologiske modeller og formler
- beskrive toksikologiske mekanismer og testmetoder
- beskrive bestemmelser for rekvirering, distribution og anvendelse af veterinære lægemidler
- beskrive lægemidlers virkningsmekanismer samt hvordan de anvendes effektivt med mindst mulige bivirkninger

Færdigheder:

- vælge og anvende relevante farmakokinetiske modeller og formler
- udarbejde et behandlingsforslag herunder forklarer farmakologiske principper bag valget af lægemiddel
- skrive en recept og forklare regler omkring udlevering af medicin
- identificere forgiftninger hos produktionsdyr og kæledyr på baggrund af anamnese, kliniske og parakliniske fund.
- anvende toksikologiske guidelines for løsning af aktuelle problemstilling herunder beskrive diagnostiske principper og rationalet bag behandling af forgiftningstilfælde
- håndterer forsøgsdyr, herunder aflivning, blodprøvetagning og infusioner

Kompetencer:

- Forstå grundlæggende farmakologiske og toksikologiske problemstillinger, herunder at kunne anvende farmakologiske og toksikologiske principper, begreber og metoder til at etablere sammenhængen mellem dosis og virkning samt til at vurdere effektiv og ansvarsfuld brug af lægemidler.

Undervisningsmateriale

Anbefalede lærebøger:

- Veterinary Pharmacology and Therapeutics, Riviere JE and Papich MG (eds.), 10 ed., 2018
- Veterinary Toxicology: Basic and Clinical Principles, Gupta R (ed.), 3 ed., 2018

Andet:

- Forelæsningsnoter med og uden speak
- Korte essayopgaver og caseopgaver, regneopgaver og MCQ-opgaver på Absalon

Kursusinformation

Sprog	Dansk
Kursuskode	SVEB13018U
Point	15 ECTS
Niveau	Bachelor
Varighed	2 blokke
Placering	Blok 3 og Blok 4 Ingen undervisning i blokuge 8 i blok 4
Skemagruppe	Tidsplan offentliggøres på Absalon senest 14 dage før kursusstart
Kursuskapacitet	186. Forbeholdt veterinærstuderende.

Studienævn
Studienævnet for Veterinærmedicin og Husdyrvidenskab

Udbydende institut
Institut for Veterinær- og Husdyrvidenskab (IVH)

Udbydende fakultet
Det Sundhedsvidenskabelige Fakultet

Kursusansvarlige
Lisbeth Høier Olsen

Undervisere
Jens Lykkesfeldt
Liselotte Bruun Christiansen
Dorte Bratbo Sørensen i øvelser vedr. Forsøgsdyrkundskab

Gemt den 27-06-2023

Appendix B

Your session results

Start to end:	May 17, 2023 08:51 to May 17, 2023 09:37
Nr. of active attendees:	24
Nr. of responses:	23
Response methods:	| Internet
Response code:	92 450 511
	ku173

Hvorfor skal i lære om toksikologi? Anvend ét til få nøgleord

Shown messages

Answers related to clinical toxicology

- Dyr skal ikke dø
- Kliniske forgiftninger, forskning
- Så man kan genkende symptomer på forgiftninger
- Forgiftning med lægemidler
- Nogle dyr æder alt
- Forgiftninger, vide noget om risici ved et lægemiddel
- Forgiftninger - og modgift
- Forgiftninger - lægemidler, pesticider, andre kemikalier, planter
- Vi vil gerne vide hvor meget dyret kan tåle af et middel, da alt er giftigt i for store mængder
- Risikovurdering i sager med mulig forgiftning
- Så vi ikke forgifter dyrene
- Død Gift, Medicinsk behandling (kemo). Fastsat parametre for at undgå toksisk effekt
- Så vi kender risikoen ved at overdosere forskellige lægemidler
- For at vide hvor grænsen er mellem effekt og toksisitet
- For at lære at behandle en forgiftning skal vi kunne genkende den og vide hvordan den diagnosticeres.
- Vi skal kende mekanismerne for at kunne gribe ind ved en forgiftning. Man kan nemt gøre det værre hvis man ikke ved man har med at gøre

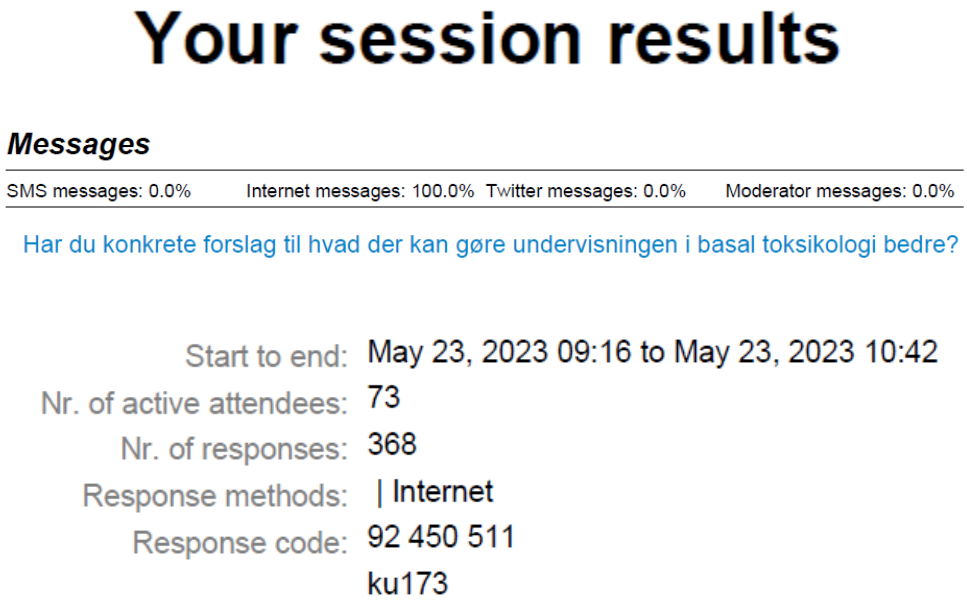
Answers related to basal toxicology

- Alt er giftigt, det handler bare om dosis
- Vigtigst at vide om farligheden ved stoffer
- Alt kan være toksisk i store nok mængder

Answers related to other subjects

- Smilla siger det er fordi dyr skal have det godt
- Fordi min roomie er toksisk
- Det er da meget godt og rart at vide
- Dødelighed

Appendix C



Your session results

Messages

SMS messages: 0.0% Internet messages: 100.0% Twitter messages: 0.0% Moderator messages: 0.0%

Har du konkrete forslag til hvad der kan gøre undervisningen i basal toksikologi bedre?

Start to end:	May 23, 2023 09:16 to May 23, 2023 10:42
Nr. of active attendees:	73
Nr. of responses:	368
Response methods:	| Internet
Response code:	92 450 511
	ku173

- Dejligt med videoer så det ikke kun er snak. Mere video
- Det funkede godt - du er en super underviser! Eneste men er, at det går for hurtigt nogle gange, men det er også et kæmpe pensum.
- Gode forelæsninger, hvor det er nemt at holde et overblik.
- Måske man kunne lave et overblik over alle beskrivelserne af de forskellige begreber. Jeg husker dem personligt ikke helt
- Gerne forklaring med flere grafer/figurer og lidt langsommere tempo til gennemgang af disse
- Det var fint
- Mere tid på at forklare af de forskellige test
- Synes det var lidt forvirrende at det hed virkningsmekanismer. Jeg forventede mekanismer lidt mere
- Synes du er så god til at mærke, hvorvidt vi er med eller ej
- Undervisningen var god nok, men selve slides var noget rodet og der blev sprunget en del i tingene
- Det går nogle gange for hurtigt
- Lidt svært at vide hvad er relevant for eksamen og hvad er relevant længere hende i uddannelsen/generelt for uddannelsen
- Mere fokus på det vi skal til eksamen

- Rart med eksempler på eksamensopgaver til sidst i forelæsningen
- Synes det har været godt uddybende. Synes der er udvalgt præcise ting som indsnævrer pensum rigtig godt
- Lidt tungt - men det er nok bare faget. Synes det er dejligt med gode slides.
- Jeg synes det var vildt svært at finde hoved og hale i, hvad det er vi skal vide og kunne i det her modul.
- Måske en revurdering om læringsmål er fokuseret til FVST frem for praktiserende dyrlæge, selvom det uden tvivl er en bred uddannelse
- Mange begreber på en forelæsning
- Nogle af de svære begreber blev gennemgået meget hurtigt
- Sætte de mange begreber op samlet i et overordnet overview
- Flere eksempler fra den "virkelige verden"
- Mere fokus på de relevante ting og ikke så meget detaljer
- Mere fokus på begreber og skal alt have samme fokus?
- Flere eksempler på brug af retningslinjer
- Slides må godt være mere overskuelige og struktureret
- Hvilke præcise guidelines vi skal have styr på fra ICH og OECD
- Inddragelse med quiz og spørgsmål er fantastiske
- Er sikker på, at læringsmålene er gennemgået tilstrækkeligt, men jeg zonede ofte ud efter de mange opremsninger af bekendtgørelser og studier osv.
- Relevans for eksamen er en rar ting her kort tid før eksamen
- Dejligt med interaktion. Altså at vi er med. Men hold det minumalt som quizzer og sådan, det virker (for mig) rigtig godt
- Super godt generelt, men kunne være fedt hvis læringsmålene kom mere 1:1 med rækkefølgen i forelæsningerne så man var sikker på hvor bredt det er ønsket
- Godt med recap fra sidste forelæsning. Godt at læringsmålene er lagt ind i slides. God info på slides. Dog langsommere gennemgang kan være nødvendig
- Evt. opsamling for kursets vigtighed en sidste dag

- Overblik over i hvor høj grad man skal kende til de forskellige organisationer også ift. hvad der er eksamensrelevant
- Fokuser på at forklare de ting, som er vigtige til eksamen, fordi det er det eneste, man kan rumme.
- Synes det var lidt svært at skelne mellem de forskellige typer af forsøg og metoder.
- Du var bedre til at gøre det tydeligt om noget var relevant eller ikke denne gang, end til sidste forelæsning, tak for det!
- Lidt hurtig gennemgang, og lidt for mange detaljer på en gang
- Det er et svært emne at skrukturer! Lav evt flere MCQ eller andre opgaver, som går det lettere at få det rette fokus
- Virkelig god underviser
- Bind det gerne sammen med det kliniske
- Oversigt slides er fantastiske. Også gerne på et højere plan så man kan se fx ALLE de lægemidler