Why are anticoagulation exam questions such a hard nut to crack?

Discrepancies in knowledge on anticoagulation pharmacotherapy between the curriculum of medical students from the Free University in Amsterdam and the core learning goals of the national pharmacotherapy exam

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ABSTRACT IN ENGLISH

BACKGROUND Medicine that affect blood coagulation are most often associated with potentially preventable medication-related hospitalizations. The prevalence of hospital admissions related to medicine (HARMs) has remained stable over the last few years, despite various efforts to lower it. A possible new angle on lowering the prevalence of HARMs is by improving workplace performance. The academic performance of medical students is predictive of workplace performance of junior doctors. Previous research has shown that medical students in the Netherlands score lower on the topic of anticoagulation on the national pharmacotherapy exam.

OBJECTIVE The aim of this study was to identify discrepancies in knowledge on anticoagulation pharmacotherapy between the curriculum of the Free University (*Vrije Universiteit*, VU) in Amsterdam and the core learning goals from the national pharmacotherapy exam (*Farmacotherapie Eindtoets*, FTE) and to provide a recommendation on how to better align the curriculum with the FTE core learning goals.

METHOD A curriculum mapping focusing on anticoagulation education was performed to compare the anticoagulation curriculum content to the FTE core learning goals. FTE exam question results on the topic of anticoagulation were analyzed to identify which subtopics had a noticeable high or low error percentage. The perspective of the medical students on the anticoagulation topics of the FTE and on their anticoagulation education was investigated through a student questionnaire. The results of these three approaches provided triangulation to identify correlations that could be possible points of improvement.

RESULTS Most anticoagulation education is taught in the third year of the bachelor and the first year of the master. The subtopics 'most important interactions', 'most important indications' and the drug group vitamin K antagonists are most prevalent in the curriculum, while 'measure to be taken if a problem/side effect occurs', 'measures to prevent problem/side effect' and the drug group direct oral anticoagulants are least prevalent. Most anticoagulation education is presented on the competence level 'remember'. Exam questions on the subtopics 'direct oral anticoagulants' and 'interactions' had significantly higher error percentages, while exam questions on the competence level 'remember' had a significantly lower error percentage. Students reported it was difficult to get an overview of all different interactions and that most of their anticoagulation knowledge has faded by the time they have to perform on the FTE.

CONCLUSION Teachers from the VU were given four points of advice. First, to spend more time on direct oral anticoagulants and less time on vitamin K antagonists. Second, to provide students with an clear overview of interactions to increase their understanding of the topic. Third, to implement more teaching moments on a higher competence level than 'remember'. Last, to provide practice exams during internships in the second year of the master to keep pharmacotherapy knowledge from fading.

SAMENVATTING IN HET NEDERLANDS

ACHTERGROND Medicijnen die de bloedstolling beïnvloeden worden het vaakst in verband gebracht met potentieel vermijdbare medicatie-gerelateerde ziekenhuisopnames. De prevalentie van medicatie-gerelateerde ziekenhuisopnames (*Hospital Admissions Related to Medicine,* HARMs) is de laatste jaren stabiel gebleven, ondanks verschillende inspanningen om deze te verlagen. Een mogelijke nieuwe invalshoek voor het verlagen van de prevalentie van HARMs is het verbeteren van de prestatie op de werkplek. De academische prestaties van geneeskundestudenten zijn voorspellend voor de werkplekprestaties van artsen in opleiding. Eerder onderzoek heeft aangetoond dat geneeskundestudenten in Nederland lager scoren op het onderwerp antistolling op de farmacotherapie eindtoets.

DOELSTELLING Het doel van deze studie was het identificeren van discrepanties in kennis over antistollingsfarmacotherapie tussen het curriculum van de Vrije Universiteit (VU) in Amsterdam en de kernleerdoelen van de farmacotherapie eindtoets (FTE) en een aanbeveling geven over hoe het curriculum beter kan worden afgestemd op de FTE kernleerdoelen.

METHODE Een curriculum mapping gericht op antistollingsonderwijs werd uitgevoerd om de inhoud van het antistollingsonderwijs uit het curriculum te vergelijken met de FTE kernleerdoelen. De FTE examenresultaten over het onderwerp antistolling werden geanalyseerd om vast te stellen welke deelonderwerpen een opvallend hoog of laag foutenpercentage hadden. Het perspectief van geneeskundestudenten op de antistollingsonderwerpen van de FTE en op hun antistollingsonderwijs werd onderzocht door middel van een studentenvragenlijst. De resultaten van deze drie benaderingen zorgden voor triangulatie waarmee correlaties werden geïdentificeerd die mogelijke verbeterpunten zouden kunnen zijn.

RESULTATEN Het meeste antistollingsonderwijs wordt gegeven in het derde jaar van de bachelor en het eerste jaar van de master. De subonderwerpen 'belangrijkste interacties', 'belangrijkste indicaties' en de geneesmiddelengroep vitamine K-antagonisten komen het meest voor in het curriculum, terwijl 'te nemen maatregel bij probleem/bijwerking', 'maatregelen ter voorkoming van probleem/bijwerking' en de geneesmiddelengroep directe orale anticoagulantia het minst voorkomen. Het meeste antistollingsonderwijs wordt gegeven op het competentieniveau 'onthouden'. Examenvragen over de deelonderwerpen 'directe orale anticoagulantia' en 'interacties' hadden significant hogere foutpercentages, terwijl examenvragen op het competentieniveau 'onthouden' een significant lager foutpercentage hadden. Studenten meldden dat het moeilijk was om een overzicht te krijgen van alle verschillende interacties en dat het grootste deel van hun antistollingskennis is weggezakt tegen de tijd dat zij de FTE moeten maken.

CONCLUSIE Het advies voor de docenten van de VU was vierledig. Ten eerste werd geadviseerd om meer tijd te besteden aan directe orale anticoagulantia en minder tijd aan vitamine K-antagonisten. Ten tweede werd geadviseerd om studenten een duidelijk overzicht van interacties te geven om hun begrip voor dit onderwerp te vergroten. Ten derde werd geadviseerd om meer onderwijsmomenten te creëren op een hoger competentieniveau dan 'onthouden'. Als laatste werd geadviseerd om oefenexamens aan te bieden tijdens de coschappen in het tweede jaar van de master om te voorkomen dat kennis over farmacotherapie vervaagt.

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2 INTRODUCTION

Hospital admissions related to medication (HARMs) have been receiving more attention in the last couple of years. In 2006 a prospective multicenter study regarding the frequency and preventability of medication-related hospitalizations was conducted in the Netherlands. It was assessed 5,6% of all hospital admissions were related to medication, of which nearly half were potentially preventable (46,5%). (1) Medicines that affect blood coagulation were most often associated with potentially preventable medication-related hospitalizations. (1-3) In a rapport by the Dutch Ministry of Health, Wellfare and Sport from 2017, it has been described that the prevalence of potentially preventable medication-related hospitalizations has stayed nearly the same over the years and anticoagulants are still mentioned among the group of drugs that cause the most hospitalizations. (4) HARMs are a burden for patients. Medication errors can cause avoidable adverse events that can lead to (re)admission to the hospital, prolonged hospital stay, increased morbidity, decreased self-reliance (i.e. due to disability) and even death. Therefore HARMs may result in an avoidable decrease of quality of life and high healthcare costs. (1, 5) The total annual costs for potentially preventable medication-related hospitalizations in the Netherlands in 2006 was estimated to be more than €94 million. (6)

In 2009 a Dutch multidisciplinary task force initiated by the Dutch Ministry of Health, Welfare and Sport developed a set of recommendations that should, in theory, lower the prevalence of hospital admissions related to medication. Based on the most common adverse drug events that caused HARMs, they formed 9 general recommendations and 34 drug-specific recommendations of whom 15 recommendations (44%) regarding medicines that affect blood coagulation. (7) A retrospective prevalence study in 2020 evaluated if these recommendations were successful in lowering the prevalence of HARM in the years 2008 to 2013. Unfortunately, the prevalence of potentially preventable HARMs has remained stable. (8) For anticoagulants specifically, the percentage of the prevalence of potentially preventable harms also remained roughly the same: 14,5% in 2006 and 13,4 in 2013. (4, 8) It is evident that different measures are needed to lower the prevalence of potential HARMs.

One possible way to reduce HARMs is to improve workplace performance. Several cohort studies from Australia have found a significant correlation between the academic performance of medical students and their workplace performance as junior doctors. A good grade point average (GPA) was predictive of good overall workplace performance. (9, 10) A study from the United States showed that one of the most important contributors to predicting residency performance was a good score on the medicine subject exam from the National Board of Medical Examiners (NMBE). (11) Therefore, it is important that students get proper education on medicine – and in this case anticoagulants – to minimize the amount of mistakes made regarding anticoagulants as a junior doctor that can result into HARMs. The hypothesis is that if through improvement of education the students score high on the anticoagulant exam questions, the prevalence of potentially preventable HARMs will decrease as well.

At most medical schools in the Netherlands, students must pass the national pharmacotherapy exam (*Farmacotherapie Eindtoets*, FTE) to become a doctor. The FTE is an initiative from the Dutch Association for Clinical Pharmacology and Biopharmacy (*Nederlandse Vereniging voor Klinische Farmacologie en Biofarmacie*, NVKFB) introduced in 2014. (12) It assesses whether or not medical students have sufficient pharmacological and pharmacotherapeutic knowledge to be able to prescribe safely. The NVKFB provides a list of core learning goals that needs to be mastered by all medical students to pass the exam. The exam consists of multiple choice questions and students need to answer at least 51 out of 60 questions (85%) correctly to pass. An overview of the different topics included in the FTE is seen in figure 1. (13)

Drug classes
Pain medication
Anticoagulants
Cardiovascular agents
Antidiabetics
Antidepressants
Benzodiazepines
Antibiotics

General subjects
Pharmacokinetics
Drug allergy
Laws and regulations
Good use of medicines
Pregnancy and lactation

Figure 1 *Overview of the different topics of the Dutch national pharmacotherapy exam. (12, 13)*

In order to master the core learning goals, the NVKFB also provides sources with up-to-date knowledge about each topic. Information is being presented in different ways: an online reader from the NVKFB, recorded lectures, an online practicing tool called Pscribe (14) that mainly focuses on pharmacotherapy, a reference to the necessary pages from the Pharmacotherapeutic Compass (15) – a Dutch drug information base, and references to additional literature, such as the book Rang & Dale's Pharmacology and a series of educational videos called Medicine of the week (16) in which the most important aspects of an individual drug or a drug class gets highlighted. (13)

Preliminary research into the causes of suboptimal anticoagulation scores on the FTE by medical students has been done at Erasmus University in Rotterdam, Radboud University in Nijmegen and Leiden University in Leiden. These studies consistently showed that Dutch medical students score lower on the topic of anticoagulants in comparison to other drug classes. These studies also showed that the anticoagulant questions of the FTE were of adequate psychometric quality and therefore not the reason for the lower exam scores. The most recent research also recommended to look deeper into the curricula. (17, 18) It is possible that the curriculum is missing some components in their education or pays little attention to certain anticoagulant topics compared to others. This study aimed to identify these possible gaps in knowledge through a triangulation of a curriculum mapping, a quantitative exam question analysis and a student questionnaire and to provide advise on how to better align the curriculum with the FTE core learning goals.

3 METHOD

This retrospective, observational cohort study aimed to identify discrepancies in knowledge on anticoagulation pharmacotherapy between the curriculum of medical students from the Free University (*Vrije Universiteit*, VU) in Amsterdam and the core learning goals from the national pharmacotherapy exam (*Farmacotherapie Eindtoets*, FTE) and to provide a recommendation on how to better align the curriculum with the FTE core learning goals.

For this study three different approaches were taken. First, a curriculum mapping focusing on anticoagulant topics was performed to compare the anticoagulant education to the FTE core learning goals. Second, the anticoagulant exam question results were analyzed to identify which subtopics had a noticeable high or low error percentage. Third, the perspective of the students on the anticoagulation topics of the FTE and on their anticoagulation education was investigated through a student questionnaire. The results of these three approaches provided triangulation to identify correlations that could be possible points of improvement.

The overarching study has received permission from the Ethical Review Board (ERB) from the Dutch Association for Medical Education (*Nederlandse Vereniging voor Medisch Onderwijs*, NVMO). Data was either made anonymous or already received anonymous, and will be stored on a secure disk at Erasmus MC.

3.1 CURRICULUM MAPPING

Curriculum mapping is a way to visualize what education is taught in a curriculum, where in the curriculum it is taught and in which way it is taught. A curriculum mapping of the anticoagulation education in the curriculum of the VU was performed between the 19th of September 2022 and the 28th of October 2022. The curriculum was then compared to the FTE core learning goals. Since the FTE offers clear goals that each medical student needs to meet to become a doctor, it was considered as a strong guideline for the minimal anticoagulant medication knowledge that a curriculum should teach its medical students. (13)

In 2015 the VU launched a new curriculum in which the FTE has been introduced. The FTE is taken during the second year of the master, thus in 2017 the first students from the VU have performed on the FTE. This new curriculum was studied. To perform the curriculum mapping, access was given to the pharmacotherapy modules from the VU in the learning management system (LMS) called Canvas. All subject matter within those modules was manually combed through for any mention of anticoagulants and all lectures were watched either online or in person. Every hit was then noted in an Excel sheet and sorted into the following categories: expected learning outcome, learning resource, curriculum placement, main or secondary focus and competence level. (19) (20) Only subject matter that every student encounters was mapped. For example, anticoagulant education that occurs during internship was not mapped, because not every student is guaranteed to have the same learning experiences. The same goes for optional subject matter. Exams were mapped as education, however, only as a repetition of previous subject matter, since no new knowledge will be introduced on exams. Additionally an interview with a group of pharmacotherapy teachers took place, where their knowledge on the curriculum was gained, where questions that arose about the curriculum during the mapping were asked and where was made sure no anticoagulation education was accidentally missed.

3.1.1 Curriculum placement

The course in which the hit is located in the modules was noted down. An overview of the distribution of the anticoagulant education across the entire curriculum was made this way. Through interviews with teachers from the VU, anticoagulant education outside of the pharmacotherapy modules – where the basics of the physiology of anticoagulation is taught – was mapped as well.

3.1.2 Main or secondary focus

This category states whether anticoagulation was the main topic of the teaching moment in which the hit was found or if it was mention adjacent to a different topic. If, for example, acetylsalicylic acid was mentioned in the scope of pain relief, anticoagulation was not the main topic and the hit was categorized as secondary focus.

3.1.3 Expected learning outcome

The expected learning outcomes were divided in categories based on the core learning goals from the FTE. The core learning goals consist of 8 topics that students need to know for 7 different drugs. (13) An overview of these core learning goals is given in figure 2. One hit could contain multiple learning goals. If a hit did not fit any of the core learning goals, it was noted separately.

Topics
Mechanism of action
Most important indications
Relevant kinetic parameters
Most important problems/side effects
Most important risk groups
Most important interactions
Measures to prevent problem/side effect
Measure to be taken if problem/side effect occurs

Drugs
Acetylsalicylic acid
Clopidogrel, ticagrelor
Acenocoumarol
Phenprocoumon
Heparin
Nadroparin
Direct oral anticoagulants

Figure 2 *Overview of the different topics and drugs of the core learning goals of the Dutch national pharmacotherapy exam. (13)*

3.1.4 Learning resources

The learning resource in which the hit was found was noted down. A single learning resource could contain multiple hits. Learning resources can, for example, vary from lectures to assignments via the online platform Pscribe, guidelines from the Dutch Association of General Practicitioners Standards, the drug information database Pharmacotherapeutic Compass, books and practice exams. If a page with information about a specific drug from the Pharmacotherapeutic Compass was mentioned, only the following parts were mapped in accordance with the teachers from the VU: indications, side effects, interactions and specifically for drugs from the same drug group the kinetic differences between them, such as duration of action, selectivity and (ir)reversible binding to target.

3.1.5 Competence level

The competence level of each hit was assessed through Bloom's taxonomy. Bloom's taxonomy is a framework for categorizing educational goals. It consists of 6 main categories, in ascending order of competency: remember, understand, apply, analyze, evaluate and create. A definition per category and an example fitting with the curriculum mapping is seen in table 1.

Table 1 *Definition of the categories of Bloom's taxonomy and examples per category.*

Competence level	Definition	Example
Remember	**Recall facts and basic concepts**	The student can name the most common ADE, indications and interactions belonging to an anticoagulant drug specified in the reader The student can name what action to take to prevent or treat a problem caused by an anticoagulant drug specified in the reader
Understand	**Explain ideas or concepts**	The student can explain the mechanism of action of an anticoagulant drug specified in the reader and how this results into an effect The student can explain the basic principle of hemostasis The student can answer closed questions about whether a certain anticoagulant drug specified in the reader is indicated for a patient in various settings*
Apply	**Use information in new situations**	The student can recommend an anticoagulant drug specified in the reader to patients in various settings* (SMAK-method)
Analyze	**Draw connections among ideas**	The student can analyze the current treatment of a patient and make changes if necessary
Evaluate	**Justify a stand or decision**	The student can argue whether or not a prescription is fitting for a specific patient case and why
Create	**Produce new or original work**	The student can independently prescribe an anticoagulant drug specified in the reader for a specific patient

**i.e. different indication, comorbidities, co-medication, allergies, age, sex, previous adverse drug events (ADE), previous treatment, etc.*

3.2 QUANTITATIVE ANALYSIS OF ANTICOAGULANT EXAM QUESTIONS

To perform a quantitative analysis of anticoagulant exam questions, data on the amount of times a certain exam question was asked and answered correctly was extracted from Testvision – the online exam environment in which the FTE is made at the VU. Exams made between 27-08-2019 and 23-02-2021, and exams made on 01-02-2022, 15-03-2022 and 05-04-2022 were extracted, because this period only contained exams that used the same 10 exam versions that were researched at the previous centers. Student name and number were already removed, only the ID produced by Testvision remained to be able to identify resits and first attempts. The baseline variables from the FTE were collected using descriptives. These variables were: total exams taken, number of first attempts and number of resits.

Each exam version consisted of 60 questions, of which 9 questions were about anticoagulation. Some anticoagulation exam questions were used in several exam versions. In total there were 49 unique questions about anticoagulation across all exam versions. These exam questions were labeled into different categories based on the labeling in previous research. (18) The categories were as follows: drug group, subject and Bloom's taxonomy level. See figure 3 for a full overview.

Drug group
Thrombocyte aggregation inhibitors
Vitamin K antagonists
(Low molecular weight) heparin
Direct oral anticoagulants
Combination of multiple drug groups

Subject
Interaction
Indication
ADME
Mechanism of action
Antidote
Dosage
Drug properties
Bridging
Discontinuation of drug
Platelet life
Side effects

Bloom's taxonomy level
Remember
Understand
Apply

Figure 3 *Overview of the categories and subcategories used to label the exam questions. (18)*

Statistical analysis was carried out with IBM SPSS Statistics version 28.0.1.0. For each main category a chi-squared test was performed to see if there was any statistically significant difference in error percentage between any of the subgroups. If this was the case, a chi-squared test was performed between all subcategories from that main category, where two subcategories at a time were analyzed to find out which subcategories specifically had a statistically significant difference in error percentage. These results were then likened to the results of the curriculum mapping to see if there is a correlation between topics with notable error percentages and the education the curriculum is offering on those topics.

3.3 Quantitative and qualitative analysis of the student questionnaire

The student questionnaire aimed to uncover possible points of improvement in the anticoagulation education from the perspective of the students. An anonymous questionnaire based on the questionnaires from previous research was revised with the help of teachers from the VU. (17, 18) The questionnaire, consisting of 8 multiple choice questions in total, contained questions about the reported study time, the topics that received the most time during studying, which learning resources were used, which information from the FTE reader was new, how prepared students were feeling for the anticoagulation exam questions and how difficult they thought the anticoagulation exam questions were. Students could give multiple answers to most questions and were free to give comments on the anticoagulation education as a whole. The full questionnaire can be viewed in Appendix I: Student questionnaire in Dutch.

The questionnaire was physically handed out to students, who made the FTE between 01-11-2022 and 10-01-2023, directly after they finished the FTE. Students had to give permission for their answers to be used anonymously. The answers to the questionnaire are not linked to their exam question results, since this were two different groups of students. The frequency of each answer and, for one question regarding the amount of hours a student spent preparing for the FTE, the mean and median of the answers were determined. If a student gave an answer in days or weeks, this was converted to 8 hours a day and weekends were excluded.

4 RESULTS

4.1 CURRICULUM MAPPING

4.1.1 Curriculum placement

Anticoagulants were mentioned in 16 out of 48 courses in the curriculum. Every year, there are at least 2 courses in which anticoagulants are mentioned – with exception of the third year of the master, in which students only follow internships and no biomedical concepts are being taught. For a complete overview of the distribution of the anticoagulant education across the entire curriculum, see Appendix II: Curriculum placement.

The basic physiological knowledge of anticoagulation was covered in three courses: Circulation and vascular disorders, Internship Internal medicine and Internship Surgery. In two of these courses, the information was taught by a team of internists and hematologists and in the other course it was taught by the usual team of pharmacology teachers. Each teaching moment covering the basic physiological principles consisted of the following subjects: primary homeostasis, secondary homeostasis, fibrinolysis and the triad of Virchow.

Assessments of anticoagulation pharmacotherapy knowledge happened between the end of the third year of the bachelor and the end of the second year of the master. The assessments consist of six oral exams and one written exam. The National Pharmacotherapy Exam takes place near the end of the second year of the master.

4.1.2 Main or secondary focus

Out of the 16 courses in which anticoagulant hits were found, 4 courses contained anticoagulation as the main focus of the teaching moment: Circulation and vascular disorders, Doctor and patient 5: Multimorbidity, Clinical Training Education: Internal medicine and Clinical Training Education: Surgery. This caused most of the anticoagulant education to be taught in the third year of the bachelor and the first year of the master. For a complete overview in which courses anticoagulant hits were mentioned in a setting where anticoagulation is the main focus and in which courses as secondary focus, see Appendix II: Curriculum placement.

4.1.3 Expected learning outcomes

All hits were sorted per topic and per drug from the core learning goals. Looking at the distribution of the topics, most hits involved the most important indications (27,5%). This was followed by the most important interactions (19,8%), mechanism of action (11,8%), most important problems/side effects (11,5%), relevant kinetic parameters of anticoagulants (9,0%), most important risk groups (7,9%), measures to prevent problem/side effect (7,4%) and, finally, the measure to be taken if a problem/side effect occurs (5,2%). An overview of this distribution is shown in figure 4.

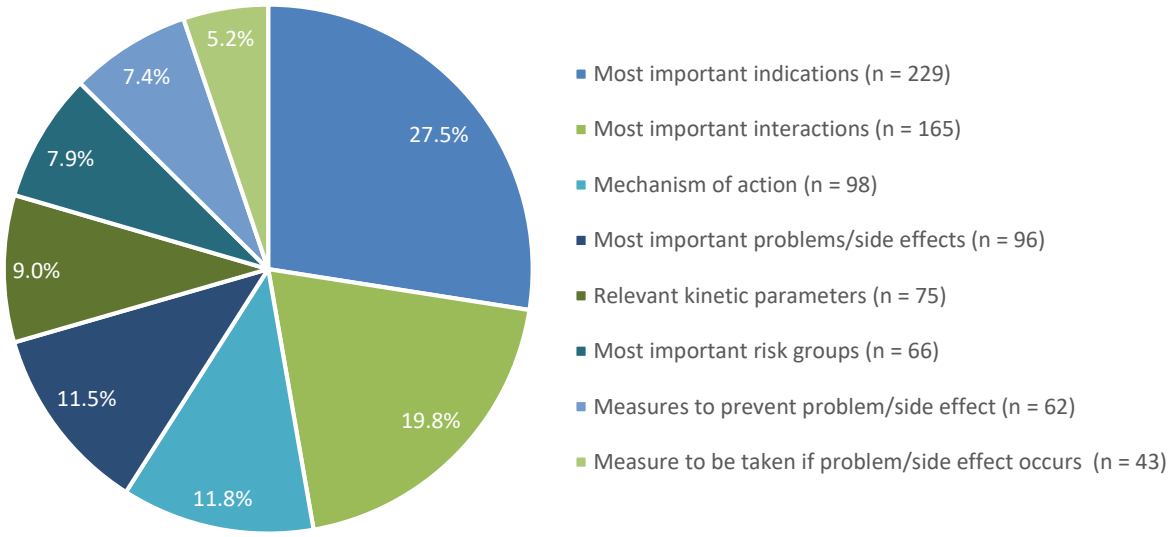

Figure 4 *The percentage of hits per topic from the core learning goals.*

When looking at the drugs involved in the core learning goals, most hits concerned acetylsalicylic acid (27,1%). This was followed by acenocoumarol (16,7%), phenprocoumon (13,8%), clopidogrel, ticagrelor (11,5%), nadroparin (11,3%), direct oral anticoagulants (9,4%) and heparin (6,7%). The least amount of hits were seen for general statements about all anticoagulants, which comprised 3,6%. An overview of this distribution is shown in figure 5. For a complete overview of the distribution of the topics and drugs of the core learning goals and their distribution among the different courses, see Appendix III: Expected learning outcomes.

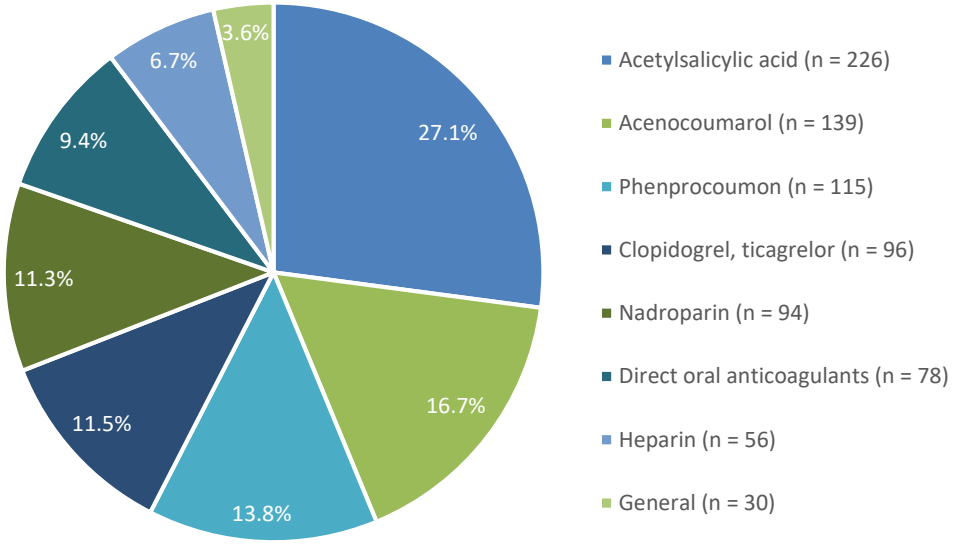

Figure 5 *The percentage of hits per drug from the core learning goals.*

Apart from the expected learning outcomes, a few other learning outcomes were occasionally seen throughout the curriculum. These learning outcomes include the most important indications, the mechanism of action and relevant kinetic parameters of dipyridamole and of the drug class fibrinolytics. Another item that showed itself a few times but was not mapped, is the comparison between vitamin K antagonists and direct oral anticoagulants and what their advantages and disadvantages are relative to each other.

4.1.4 Learning resources

In total 13 different learning resources were applied to teach students about anticoagulants. Lectures were the most used learning resource with 29,5%. This was followed by the drug information database Pharmacotherapeutic Compass (15,7%), assignments from Pscribe (12,0%), the National Pharmacotherapy Exam reader (9,2%), Clinical Training Education presentations (8,1%), guidelines from the Dutch Association of General Practicitioners Standards (7,9%), the book Rang and Dale's Pharmacology (5,5%), medicine of the week educational videos (4,1%), other guidelines (3,1%), basic knowledge tests (2,2%), the guideline database (1,4%) and patient cases from practicals (1,4%). An overview of this distribution is shown in figure 6. The 'other guidelines' consist of the START-STOPP-criteria and the summary of the guideline Anticoagulation with LMWH in renal insufficiency, both of which were only mentioned once, during the course Doctor and patient 5: Multimorbidity at the end of the third year of the bachelor. For a complete overview of the distribution of the learning resources across the courses, see Appendix IV: Learning resources.

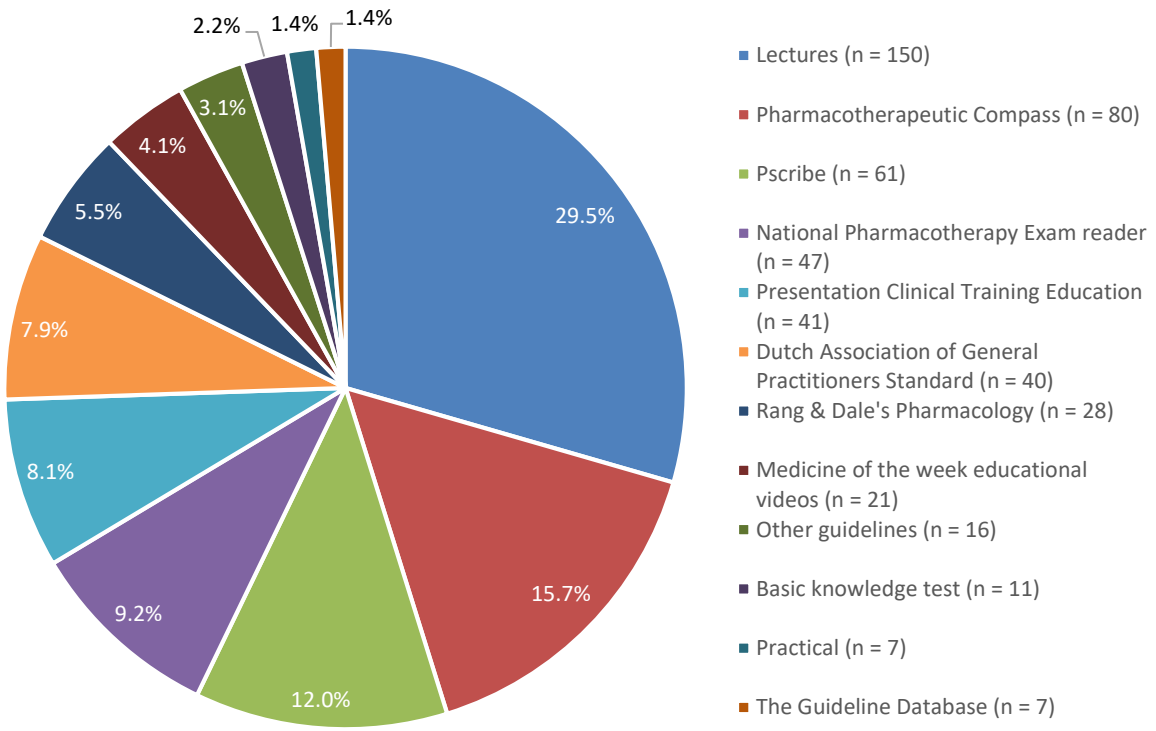

Figure 6 *The percentage of hits per learning resource.*

4.1.5 Competence level

The competence level was assessed per hit. In the curriculum as a whole, 91,6% of hits were assessed on the competence level of 'remember'. An overview of this distribution is seen in figure 7. The distribution of the competence levels was also visualized as a percentage of the total hits per course and can be viewed in Appendix V: Competence level. Most courses were entirely on the competence level of 'remember'. A few courses had some hits on the level of 'understand' and 'apply', but these competence levels combined never comprised more than 25% of the course.

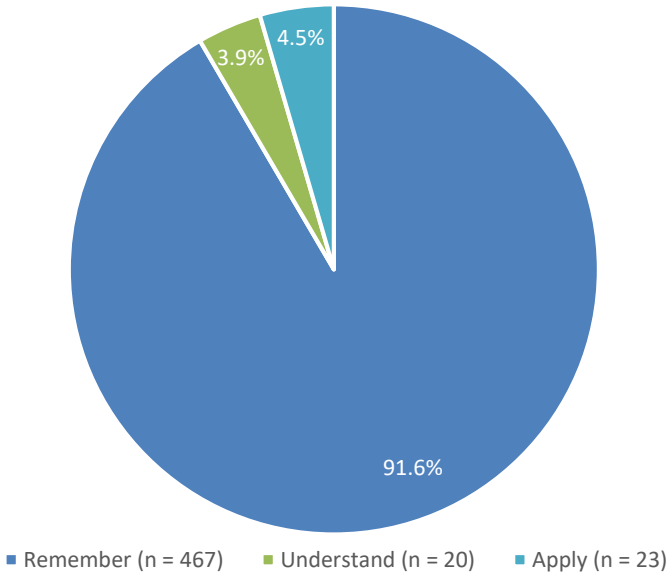

Figure 7: *The percentage of competence levels in the entire curriculum.*

4.2 QUANTITATIVE ANALYSIS OF ANTICOAGULANT EXAM QUESTIONS

The baseline variables from the FTE were established. In total 626 exams were taken, of which 524 were first attempts and 102 were resits.

For all main categories – drug group, subject and Bloom's taxonomy level – a statistically significant difference in error percentage was found between one or more of their subcategories. Therefore an analysis between each individual subcategory within each category was performed. An overview of all p-values of these subcategory comparisons are found in Appendix VI: Significance values. Additionally, all error percentages from each subcategory are shown in tables 2-4.

Within the category 'drug group', a statistically significant difference was found between the error percentages of the subcategory 'direct oral anticoagulants' and all other subcategories ($p < 0{,}001$ for all comparisons). Exam questions about direct oral anticoagulants had a significantly higher error percentage than all other drug groups. Between the subcategories 'vitamin K antagonists' and 'combination of multiple drug groups' a statistically significant difference between error percentages was also found ($p = 0{,}012$). Exam questions about vitamin K antagonists had a significantly higher error percentage than exam questions that contained a combination of multiple drug groups.

Table 2 *The error percentages for each subcategory within the category drug group and the amount of times a question about each subcategory is answered. Significantly higher error percentages are shown in red.*

Drug group	Error percentage
Thrombocyte aggregation inhibitors (n = 1766)	11,2%
Vitamin K antagonists (n = 1757)	12,5%
(Low molecular weight) heparin (n = 660)	10,8%
Direct oral anticoagulants (n = 510)	**20,4%**
Combination of multiple drug groups (n = 893)	9,2%

Within the category 'subject', a statistically significant difference in error percentages was found between the subcategory 'interaction' and the subcategories 'indication', 'ADME', 'antidote' and 'drug properties' (respectively p = 0,010; p = 0,001; p < 0,001; p = 0,010). Exam questions about interactions had a significantly higher error percentage than the other previously mentioned subcategories. There was a statistically significant difference in error percentage between the subcategory 'discontinuation of drug' and all other subcategories (p < 0,001 for all comparisons). Exam questions about the discontinuation of a drug had a significantly higher error percentage than all other subcategories.

Table 3 *The error percentages for each subcategory within the category subject and the amount of times a question about each subcategory is answered. Significantly higher error percentages are shown in red.*

Subject	Error percentage
Interaction (n = 1268)	**14,4%**
Indication (n = 641)	10,1%
ADME (n = 508)	8,7%
Mechanism of action (n = 571)	11,7%
Antidote (n = 764)	8,9%
Dosage (n = 88)	8,0%
Drug properties (n = 870)	10,6%
Bridging (n = 366)	12,6%
Discontinuation of drug (n = 268)	**29,9%**
Platelet life (n = 104)	9,6%
Side effects (n = 138)	8,7%

Within the category 'Bloom's taxonomy level' a statistically significant difference in error percentages was found between the subcategory 'remember' and the subcategories 'understand' and 'apply' (respectively p = 0,007; p = 0,011). Exam questions that were on the Bloom's taxonomy level of remembering had a significantly lower error percentage than exam questions with the levels understand and apply.

Table 4 *The error percentages for each subcategory within the category Bloom's taxonomy level and the amount of times a question about each subcategory is answered. Significantly lower error percentages are shown in blue.*

Bloom's taxonomy	Error percentage
Remember (n = 3426)	**11,0%**
Understand (n = 2061)	13,4%
Apply (n = 99)	19,2%

4.3 Quantitative and qualitative analysis of the student questionnaire

The questionnaire was filled in by 97 students. All comments from students that further explained their answer choices were bundled in Appendix VII: Student responses.

4.3.1 Reported study time and topics of focus

The mean time students reported on preparing for the FTE as a whole was 23,8 hours, with a median of 20 hours. Students were asked which three topics they spent the most time on while preparing for the FTE. The topics anticoagulants (n = 80), cardiovascular agents (n = 73) and antidiabetics (n = 58)

were most often named. When asked why they spent a lot of time on anticoagulants, most students reported that anticoagulants were a difficult topic for them (n = 51) and/or their knowledge about the topic had faded (n = 39). An overview of student responses to these topics is seen in figure 7 and 8. Students that expanded on their answer choice mentioned having difficulties with remembering all interactions and different types of anticoagulation medication.

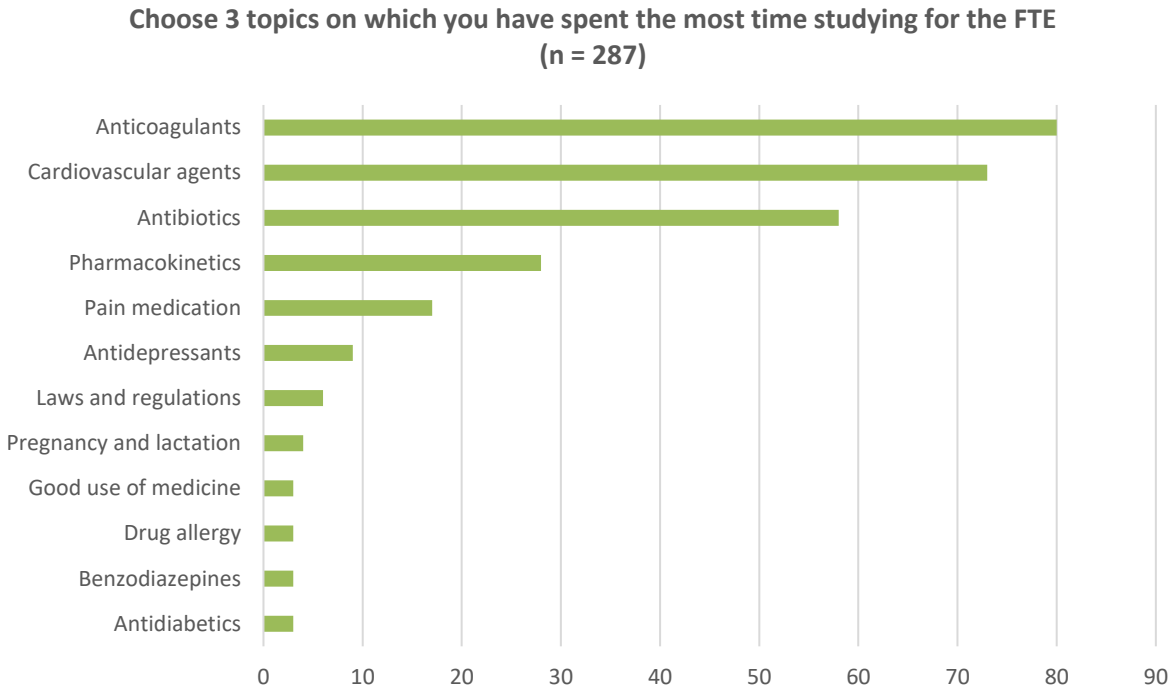

Figure 7 *The amount of student responses per answer option. Students could select multiple answers.*

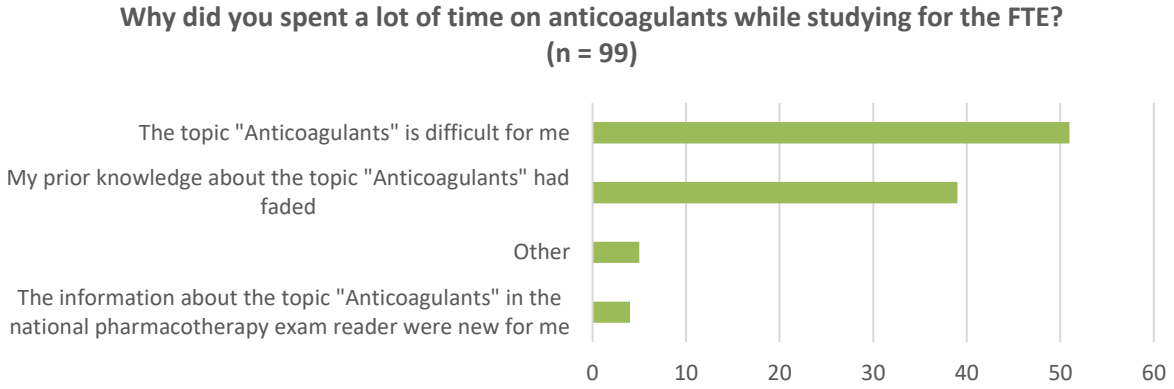

Figure 8 *The amount of student responses per answer option. Students could select multiple answers. Only students who selected the topic of anticoagulants in the question above had to answer this question.*

4.3.2 Learning resources

The national pharmacotherapy exam reader was named by 94 of 97 students as being used to prepare for the topic anticoagulation specifically. Other learning resources that were named often are practice cases on Pscribe (n = 50) and the drug information database Pharmacotherapeutic Compass (n = 28). An overview of student responses to this topic is seen in figure 9. Students that chose the 'Other' answer option most often noted using the Plexus app, videos from YouTube such as RECIPE videos, self-made summaries from previous years or making practice exams.

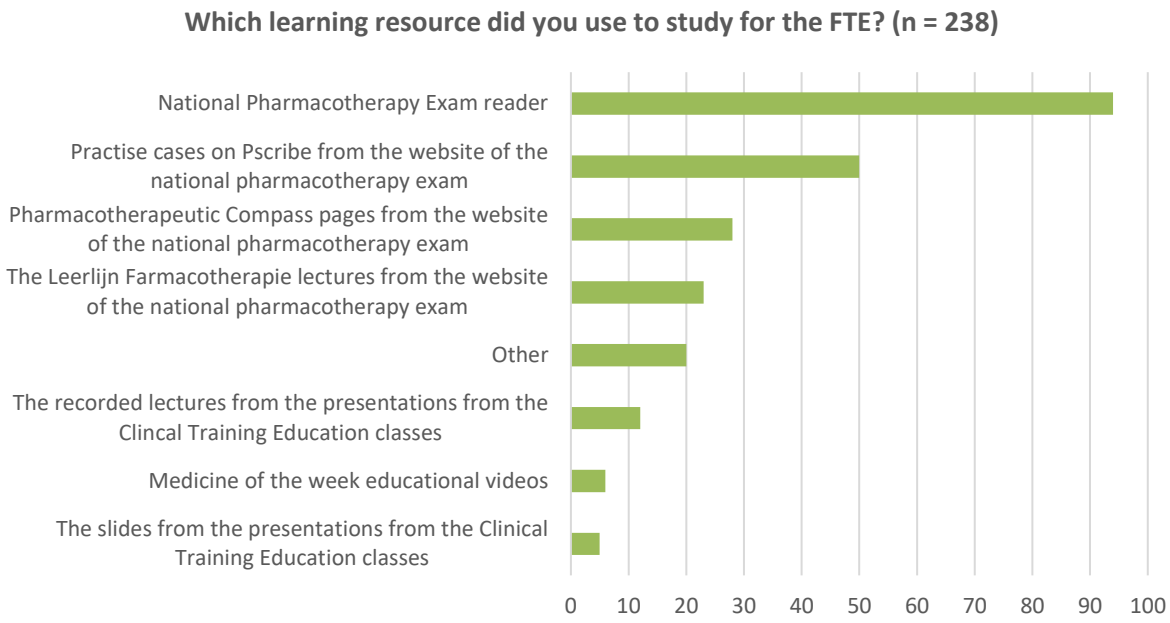

Figure 9 *The amount of student responses per answer option. Students could select multiple answers.*

When asked which topics of the national pharmacotherapy exam reader contained new information for the students, the most important interactions (n = 49), relevant kinetic parameters (n = 36) and the most important indications (n = 49) were most often selected. An overview of student responses to this topic is seen in figure 10. Students expanded on their answer option by saying knowledge about interactions, kinetic parameters and indications had faded. Measures to take when a bleeding takes place was unknown for some students. Other students noted there was no new information, but that the reader did give a good overview of the subject matter.

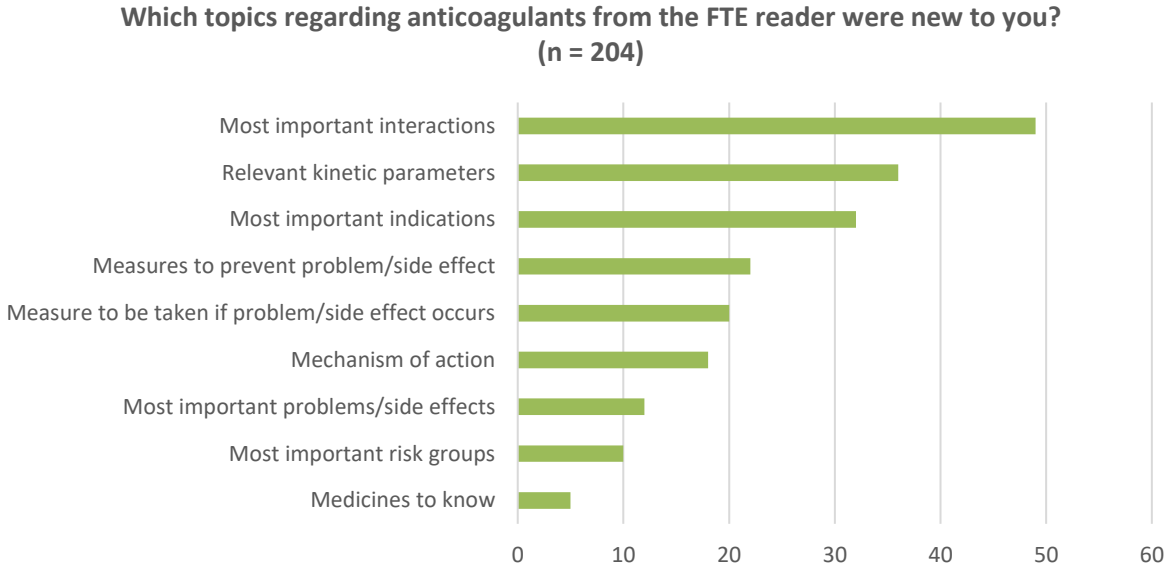

Figure 10 *The amount of student responses per answer option. Students could select multiple answers.*

4.3.3 Preparedness and difficulty of anticoagulation questions

Students were asked on a scale of one to five how prepared they were feeling for the anticoagulation questions on the basis of their anticoagulation education – one meaning not feeling prepared at all and five meaning feeling completely prepared. Most students scored a four (n = 46), followed by three

(n = 22), five (n = 14) and two (n = 13). None of the students scored an one. An overview of student responses to this topics is seen in figure 11. Further student responses expanded on not feeling prepared due to faded knowledge, mostly about interactions, kinetic parameters and measures to take when a bleeding takes place. Other students mentioned feeling prepared since the FTE reader had a good overview of all information needed. Some students asked for more practice exams in order to feel prepared.

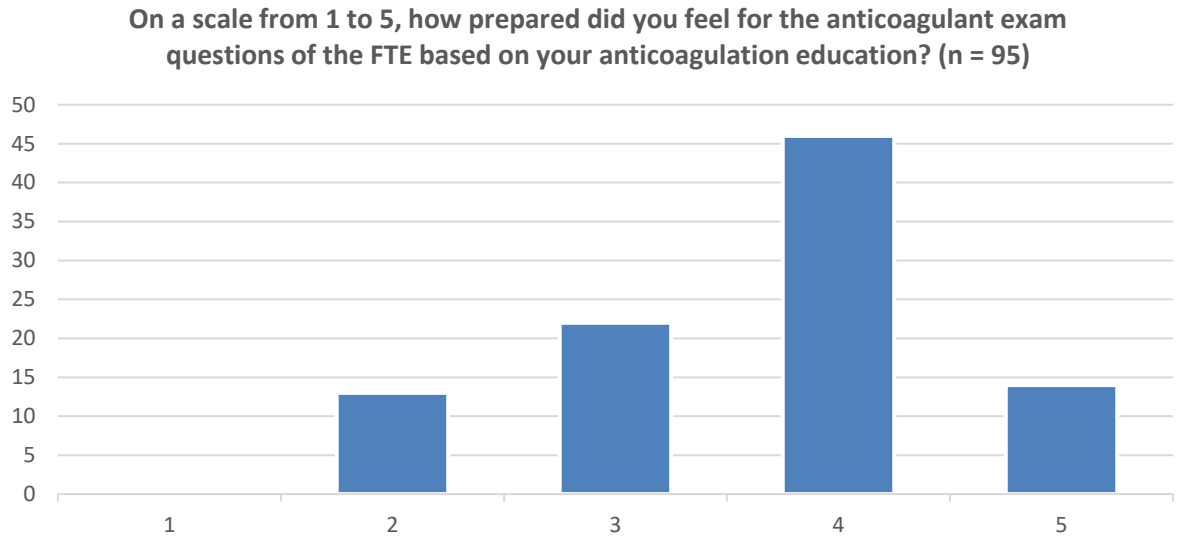

Figure 11 *The amount of times an answer has been selected. The answer was scored on a Likert scale, in which 1 meant not feeling prepared at all and 5 meant feeling completely prepared.*

When asked what students thought of the difficulty level of the anticoagulation questions, 80 of 97 students reported the questions were on the right difficulty level. An overview of student responses to this topic is seen in figure 12.

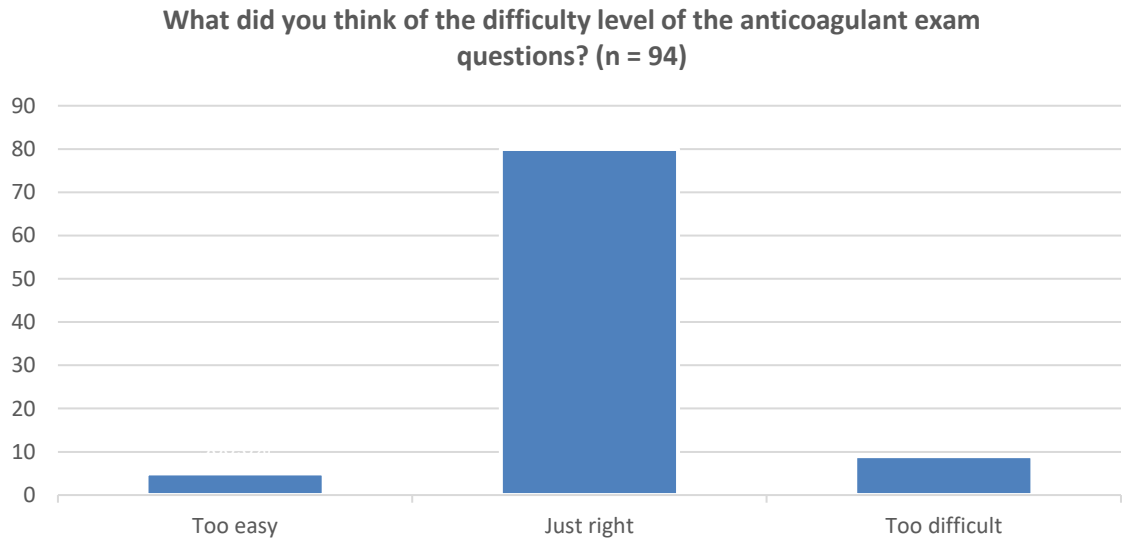

Figure 12 *The amount of times an answer has been selected.*

5 DISCUSSION

Triangulation of the three data sources revealed that the drug group 'direct oral anticoagulants' and the topic 'interactions' had a significantly higher error percentage than other subcategories. Direct oral anticoagulants were expressed less in the curriculum compared to other drug groups, while mentions of interactions were seen a lot compared to other topics. Students noted it was difficult to get an overview of all interactions. There was a year-long gap between the final course that focusses on anticoagulation and the moment the national pharmacotherapy exam takes place, with students reporting their anticoagulation knowledge has faded during that time. Exam questions on the competence level 'remember' had a lower error percentage than other competence levels and most education was given on the competence level 'remember' as well.

5.1 INTERPRETATIONS

Quantitative analysis of anticoagulant exam questions showed that questions about direct oral anticoagulants had a significantly higher error percentage than other drug groups, which might be explained by the curriculum map showing that direct oral anticoagulants were mentioned less often than other drug groups. Analysis of exam questions further showed that questions about interactions had a higher error percentage than most other subject categories, despite the topic 'interactions' having the second most amount of hits in the curriculum. Students reported that it is difficult to get an overview of all different interactions. The same was reported about the topic 'indications', even though this was not reflected in exam results and the topic 'indications' had the most hits within the curriculum map. From the students' point of view, clear overviews of these topics were needed in order to feel more prepared for the FTE. It appears that not only the amount of time spent on a topic, but also the way in which the knowledge is presented or the way in which the students need to interact with the knowledge is of importance as well.

Anticoagulation education was mostly centered in the last year of the bachelor and the first year of the master. The FTE was performed at the end of the second year of the master, more than a year later. This year-long gap might explain why students state that their knowledge about anticoagulation has faded. This could highlight the importance of frequent repetition of a topic throughout the curriculum, as the same phenomenon was seen in all previously studied centers. (17, 18, 21) The lack of repetition of anticoagulation knowledge in the second year of the master might contribute to the higher error percentages on the topic of anticoagulation on the FTE.

Exam questions on the competence level 'remember' had a significantly lower error percentage than exam questions on higher competence levels. Most anticoagulation education was presented on the competence level 'remember', which might explain why students score better on exam questions from this competence level. However, these results should be interpreted with caution. It is difficult to predict on which competence level students engage with course material. For example, during an interactive part of a lecture where a case is being discussed, students that actively participate with unraveling the case might be engaging on the competence level 'understand' or 'apply', while students who only listen and take notes of the case being unraveled are engaging on the competence level 'remember'. In discussions with teachers from the VU it also became apparent that some assignments they intended to be on the competence level 'understand' were interpreted as 'remember' within this study.

5.2 IMPLICATIONS

More teaching moments on direct oral anticoagulants might be needed to improve student understanding for this drug group. With prescription behavior currently shifting from vitamin K antagonists to direct oral anticoagulants, it might be considered whether the curriculum currently spends too much time on vitamin K antagonists in comparison to direct oral anticoagulants. It is advised that some of the time spent on vitamin K antagonists can therefore be shifted onto the direct oral anticoagulants instead.

It was advised that more repetition of anticoagulation education was necessary in the second year of the master. However, due to the abundance of internships during that year, this proved to be difficult. Teachers from the VU also noted that an optional teaching moment close to the FTE already exists, in which anticoagulation knowledge, among other subject matter, is practiced. In discussions with teachers from the VU it was then suggested that complementary FTE practice exams could be prepared, which would be released per FTE topic relevant to the internship. For example, the part of the practice exam with the topic of anticoagulation would be released during the surgery internship.

In a study from Keijsers et al. it was suggested that all medical centers from The Netherlands need to give more emphasis to the acquisition of skills. At the time of the study, teachers rated their students as being only moderately well-prepared for their careers after graduation. The study states that knowledge is needed as a solid basis, but implementing this knowledge on a higher competence level needs to be practiced as well. (19) Since most hits in the curriculum were assessed on the competence level 'remember' and students themselves expressed a need for more practice assignments and exams, it is recommended to implement more teaching moments in which students have a chance to engage with the subject matter on a competence level of 'understand' or 'apply', for example through more complex Pscribe assignments or interactive segments during lectures.

This is the first medical center in the Netherlands for which a detailed curriculum mapping was performed on anticoagulation medication. It is recommended that a detailed curriculum mapping using the same categories is performed for all medical centers in The Netherlands in order to be able to compare the curricula and eventually gain national implications for anticoagulation education improvement.

5.3 STRENGTHS AND LIMITATIONS

As seen by other curriculum mapping studies, curriculum mapping is a complex process that is quite time consuming. (22) However, the big database it produced provided much useful information, especially in combination with the involvement of the teachers from the VU during and after the curriculum mapping. This way, the curriculum was viewed from both the researcher and teachers' perspectives, which sometimes caused surprising results. For example, teachers from the VU were of the impression that students would not use Pscribe as a resource for studying for the FTE much, since the they not actively encourage these assignments. Students, however, reported Pscribe among their most used learning resource.

Another strength of this study was the use of a triangulation of three approaches to answer the research question. This way more relevant explanations could be found for notable results and a more targeted advice for the VU specifically could be formulated. The fact that 97 students completed the questionnaire gave more reliability to the results gained from the questionnaire as well, as this is a big enough sample size to get a comprehensive view of an possible issue.

However, this study had some limitations as well. During the curriculum mapping, every mention of anticoagulation was mapped. No difference was made between the extensiveness of each hit,

therefore a brief mention of anticoagulants in a lecture unrelated to anticoagulation carried the same weight as an assignment involving the application of anticoagulant knowledge on Pscribe. This causes possible overestimation or underestimation of the presence of the expected learning outcomes of the anticoagulation education. For example, if most hits from the topic 'interactions' were from Pscribe assignments, it is expected that students would have a greater understanding on the topic than when most hits are only brief mentions in lectures unrelated to anticoagulation.

The use of different subject topics in the categorization of the curriculum map and the categorization of the FTE exam question results made the comparison between the two approaches more difficult. It was seen that the topic 'discontinuation' had a significantly higher error percentage, but in the curriculum map the topic 'discontinuation' is not specifically mapped and therefore the curriculum map could not provide an explanation. It is therefore recommended to use the same categorization for both approaches in future research.

On a similar note, two different groups of students were analyzed for the FTE exam question results and the student questionnaire, thus the opinions of the students could not be linked to their own exam results. For this study the choice was made to analyze two different student groups in order to guarantee student anonymity. The results gained from this study were still valuable and insightful, however for future research it is recommended to use the same student group for both approaches in order to be able to assess whether students' opinions match their exam results.

In this study, it was chosen not to map the comparison between vitamin K antagonists and direct oral anticoagulants and what their advantages and disadvantages are relative to each other, because not all points of comparison could be mapped within the FTE core learning goals. These points comparisons consisted of, for example, INR measurements, the different approaches to manage bleeding, interactions, and costs. In hindsight, the points of comparison that could be mapped within the FTE core learning goals should have been mapped. The comparison between two drug groups forces students to engage on a higher competence level with the subject matter by applying their knowledge about both drug groups. However, since these comparisons only occurred 3 times in the entire curriculum, of which once in a guideline from the Dutch Association of General Practicitioners Standards and twice in a lecture, it is expected that the decision to not map these comparisons did not have a big impact on the final advise given.

6 CONCLUSION

The advice given to teachers from the VU to better align their curriculum with the FTE core learning goals consisted of four points. First, more emphasis could be given on direct oral anticoagulants by redirecting some of the time spent on vitamin K antagonists towards direct oral anticoagulants. Second, the understanding of all different interactions of anticoagulation medication could be increased by providing students with a clear overview. Third, it was recommended to implement more teaching moments in which application of pharmacotherapy knowledge is practiced, for example through assignments on Pscribe. Last, anticoagulation knowledge could be kept from fading by providing practice exams that are divided per topic relevant to the interships the students are following in the second year of the master.

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8 APPENDIX I: STUDENT QUESTIONNAIRE

Beste student,

Zojuist heb je de farmacotherapie eindtoets gemaakt. Om de toets en het onderwijs te verbeteren zijn wij benieuwd naar hoe jullie de toets hebben ervaren. Daarom willen je we je vragen om onderstaande vragenlijst in te vullen en deze in te leveren bij de docent. Het invullen van de vragenlijst is anoniem. Mochten er vragen zijn, stuur een mail naar a.jordan@erasmusmc.nl. Alvast bedankt voor je input!

☐ Ik geef toestemming om de antwoorden op deze vragen te gebruiken voor onderzoek

Vraag 1
Hoeveel tijd heb je ongeveer besteed aan het studeren voor deze toets?
_____ uur.

Vraag 2
Kies drie onderwerpen waar je de meeste tijd aan hebt besteed bij het studeren voor deze toets:

- ☐ Pijnmedicatie
- ☐ Antistolling
- ☐ Cardiovasculaire middelen
- ☐ Antidiabetica
- ☐ Antidepressiva
- ☐ Benzodiazepines
- ☐ Antibiotica
- ☐ Farmacokinetiek
- ☐ Geneesmiddelallergie
- ☐ Wet en regelgeving
- ☐ Goed gebruik geneesmiddelen
- ☐ Zwangerschap en lactatie

Indien je bij vraag 2 het onderwerp “Antistolling” WEL hebt aangekruist: ga door naar vraag 3.
Indien je bij vraag 2 het onderwerp “Antistolling” NIET hebt aangekruist: sla alleen vraag 3 over en ga direct door naar vraag 4.

Vraag 3
Waarom heb je veel tijd besteed aan het onderwerp “Antistolling”? Je kunt meerdere antwoorden aankruisen.

- ☐ Mijn voorkennis over het onderwerp “Antistolling” was weggezakt
- ☐ De informatie over het onderwerp “Antistolling” in de Farmacotherapie Eindtoets Reader was nieuw voor mij
- ☐ Het onderwerp “Antistolling” vind ik lastig
- ☐ Anders,
  namelijk:_____

Vraag 4
Welke bronnen heb je gebruikt om te studeren voor het onderwerp “Antistolling”? Je kunt meerdere antwoorden aankruisen.

- ☐ De Farmacotherapie Eindtoets Reader
- ☐ De ingesproken PowerPoint (Leerlijn Farmacotherapie) op de website van de farmacotherapie eindtoets
- ☐ De casuïstiek op Pscribe vanuit de website van de farmacotherapie eindtoets
- ☐ De Farmacotherapeutisch Kompas pagina’s vanuit de website van de farmacotherapie eindtoets
- ☐ De ‘Geneesmiddel van de week’-filmpjes
- ☐ De opgenomen colleges vanuit de KTO-lessen
- ☐ De slides van de presentaties KTO vanuit de KTO-lessen
- ☐ Anders, namelijk: _____

Vraag 5
In welke mate voelde je je voldoende voorbereid op de vragen over het onderwerp “Antistolling” aan de hand van het antistollingsonderwijs? Geef dit een cijfer tussen de 1 en 5.

Helemaal niet voldoende voorbereid	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐	Helemaal voldoende voorbereid

Licht je antwoord hier zo specifiek mogelijk toe:_____
_____
_____
_____

Vraag 6
Welke onderdelen over het onderwerp “Antistolling” uit de Farmacotherapie Eindtoets Reader waren nieuw voor jou? Je kunt meerdere antwoorden aankruisen.

- ☐ Te kennen geneesmiddelen
- ☐ Werkingsmechanismen
- ☐ Belangrijkste indicaties
- ☐ Relevante kinetische gegevens
- ☐ Belangrijkste problemen/bijwerkingen
- ☐ Belangrijkste risicogroepen
- ☐ Belangrijkste interacties
- ☐ Maatregelen ter preventie van probleem/bijwerking
- ☐ Maatregel te nemen als probleem/bijwerking zich voordoet

Licht je antwoord hier zo specifiek mogelijk toe:_____
_____
_____
_____

Vraag 7
Wat vond je van de moeilijkheidsgraad van de vragen over het onderwerp “Antistolling”?

- ☐ Te makkelijk
- ☐ Op juist niveau
- ☐ Te moeilijk

Vraag 8
Wil je nog iets anders kwijt over de farmacotherapie eindtoets of het farmacotherapie onderwijs? Dit mag in het algemeen of specifiek over het onderwerp “Antistolling”.

_____
_____
_____
_____

9 APPENDIX II: CURRICULUM PLACEMENT

Figure A1 *Curriculum map of the anticoagulation medication in the medicine curriculum of the VU. Names of courses are displayed in Dutch.*

Table A1 *Placement of all exams as confirmed by teachers from the VU, including exams that do not cover anticoagulation.*

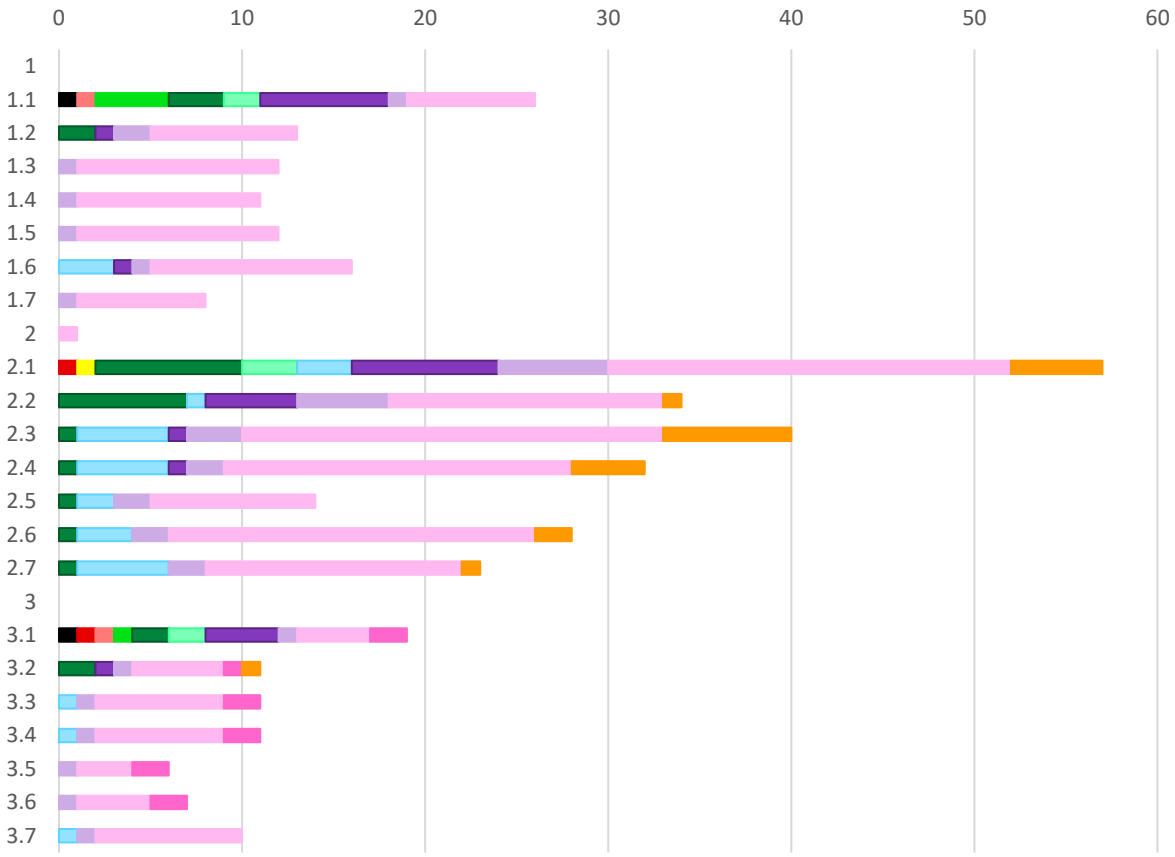
Exam	Placement	Course	Comment
Stationstoets (STAT) B2	Bachelor end year 2	Arts en patiënt 4: Evidence based medicine	Assessment independent of the course
Stationstoets (STAT) B3	Bachelor end year 3	Arts en patiënt 5: Multimorbiditeit	Assessment independent of the course
Stationstoets (STAT) VCP	Master start year 1	Voorbereidend coschap	
Mondeling klinisch redeneren (MKR) 1	Master end year 1	Coschap Heelkunde	
Mondeling klinisch redeneren (MKR) 2	Master start year 2	Coschap Psychiatrie	
Mondeling klinisch redeneren (MKR) 3	Master mid year 2	Coschap Kindergeneeskunde	
Mondeling klinisch redeneren (MKR) 4	Master end year 2	Coschap Huisartsen-geneeskunde	Most students take the FTE before MKR 4
Farmacotherapie Eindtoets (FTE)	Master end year 2	Coschap Huisartsen-geneeskunde	Most students take the FTE before MKR 4

10 APPENDIX III: EXPECTED LEARNING OUTCOMES

LEGENDA

Arts en patiënt 1: Soma en psyche	Homeostase
Schade, afweer en herstel	Arts en patiënt 3: Context
Sekse, seksualiteit en relaties	Spijsvertering en stofwisseling
Circulatie en vasculaire stoornissen	Neurologie en oogheelkunde
Psychisch funtioneren en cognitie	Arts en patiënt 5: Multimorbiditeit
Voorbereidend coschap	KTO Interne geneeskunde
KTO Heelkunde	KTO Psychiatrie
KTO Gynaecologie, verloskunde en kindergeneeskunde	KTO Ouderengeneeskunde

	Topics		**Drugs**
1.x	Mechanism of action	**x.1**	Acetylsalicylic acid
2.x	Most important indications	**x.2**	Clopidogrel, ticagrelor
3.x	Relevant kinetic parameters	**x.3**	Acenocoumarol
4.x	Most important problems/side effects	**x.4**	Phenprocoumon
5.x	Most important risk groups	**x.5**	Heparin
6.x	Most important interactions	**x.6**	Nadroparin
7.x	Measures to prevent problem/side effect	**x.7**	Direct oral anticoagulants
8.x	Measure to be taken if problem/side effect occurs		



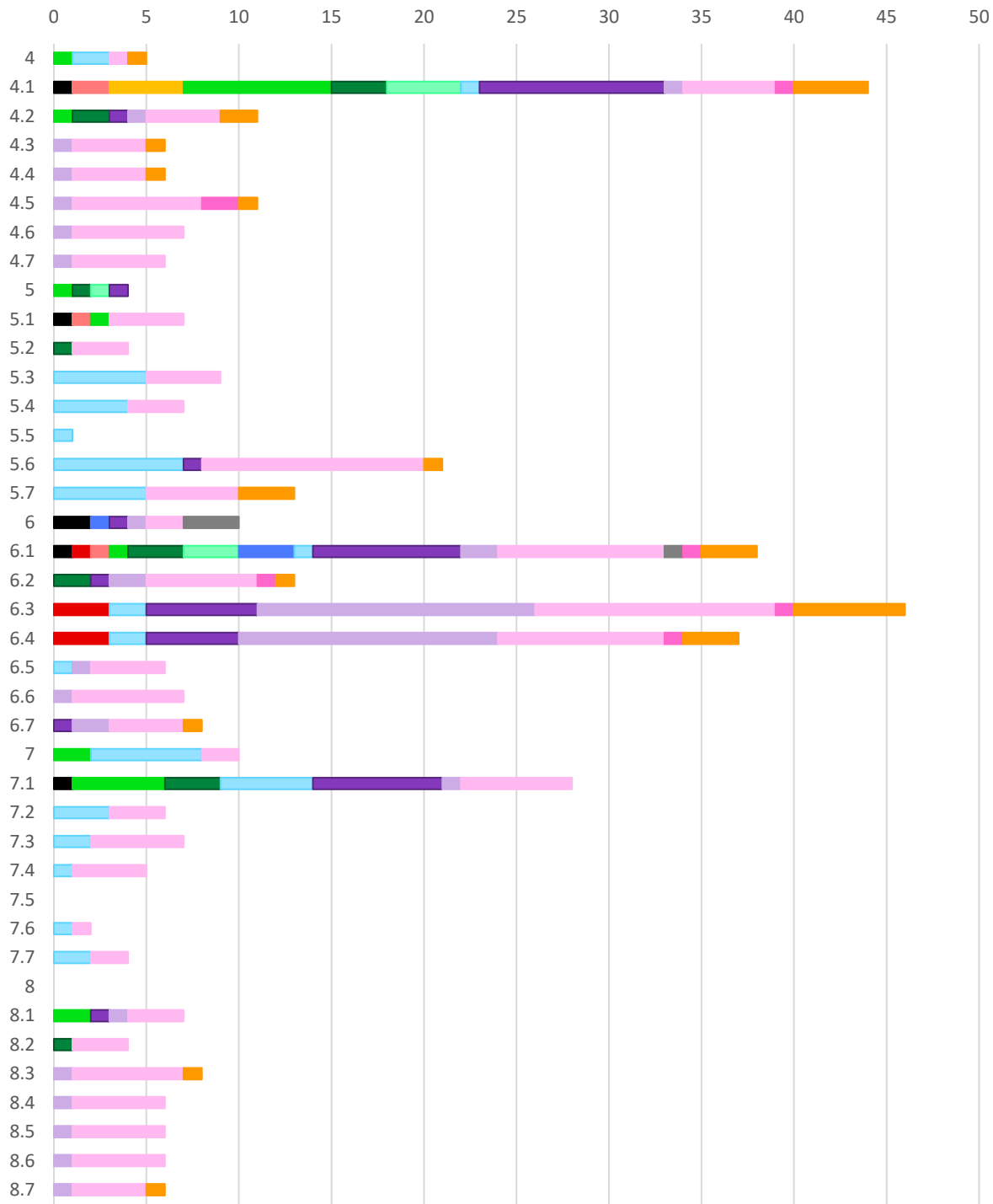


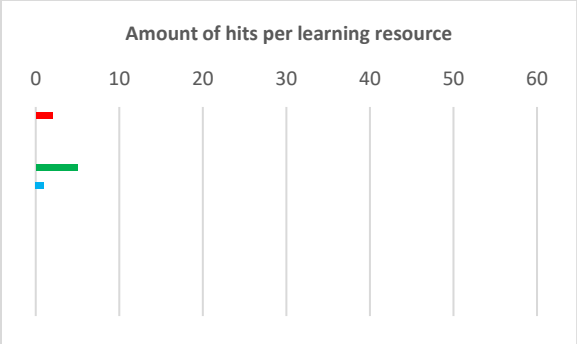
Figure A2 *The amount of hits per expected learning outcome and the distribution of courses per learning outcome. Names of courses are displayed in Dutch.*

11 APPENDIX IV: LEARNING RESOURCES

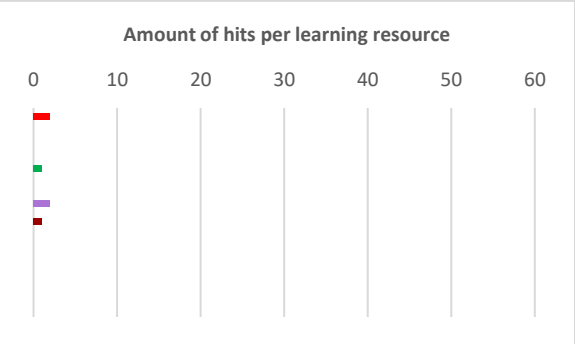
LEGEND

Lectures	Dutch Association of General Practitioners Standard
Practical	Pharmacotherapeutic Compass
Presentation Clinical Training Education	The Guideline Database
Rang & Dale's Pharmacology	National Pharmacotherapy Exam reader
Basic knowledge test	Medicine of the week educational videos
Pscribe	Other guidelines

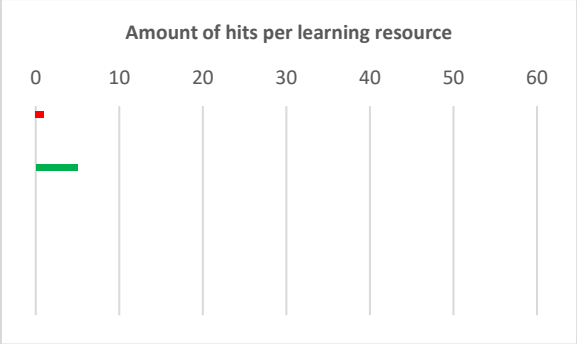
Arts en patiënt 1: Soma en psyche



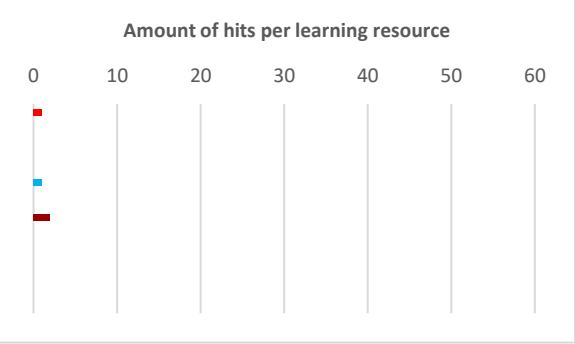
Homeostase



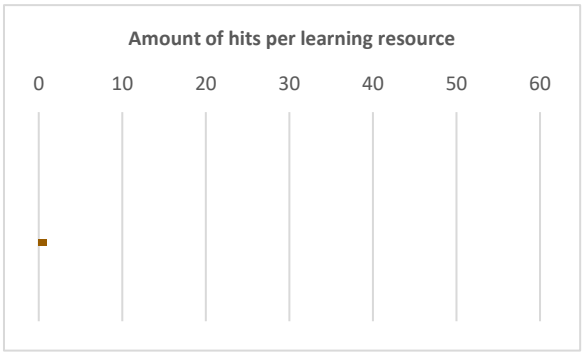
Schade, afweer en herstel



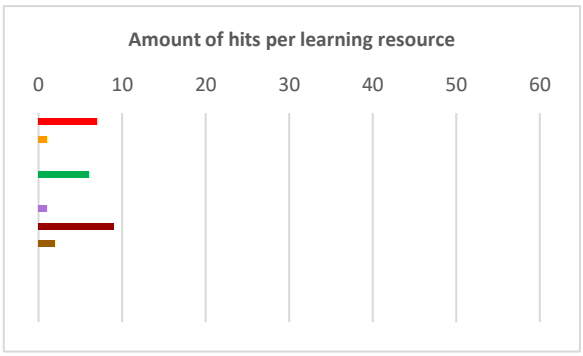
Arts en patiënt 3: Context



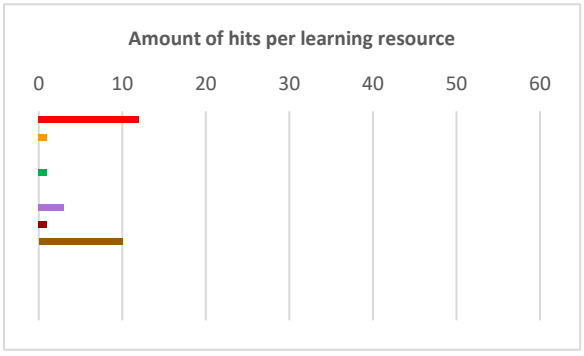
Sekse, seksualiteit en relaties



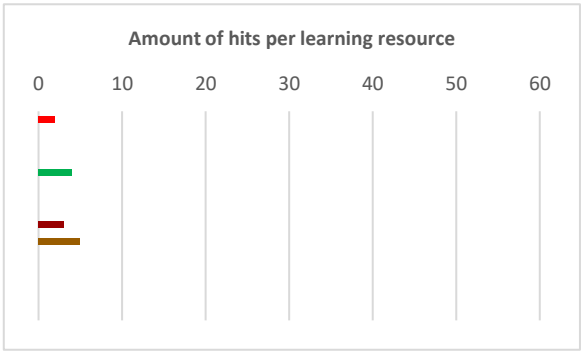
Spijsvertering en stofwisseling



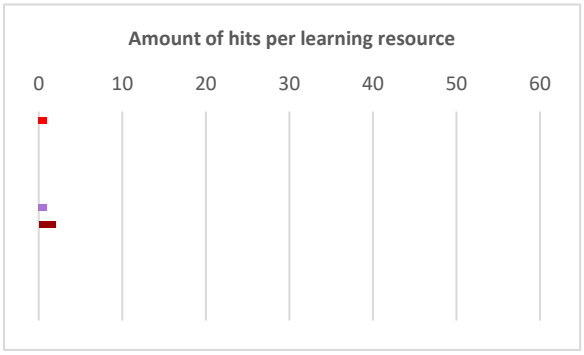
Circulatie en vasculaire stoornissen



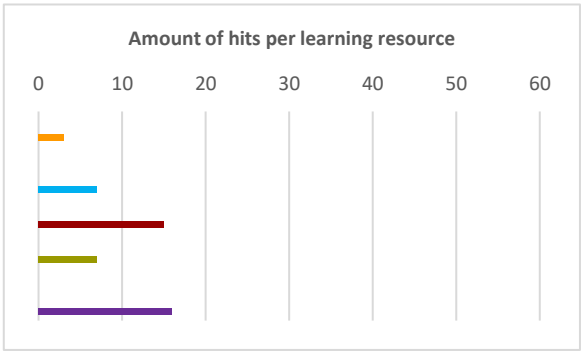
Neurologie en oogheelkunde



Psychisch functioneren en cognitie



Arts en patiënt 5: Multimorbiditeit



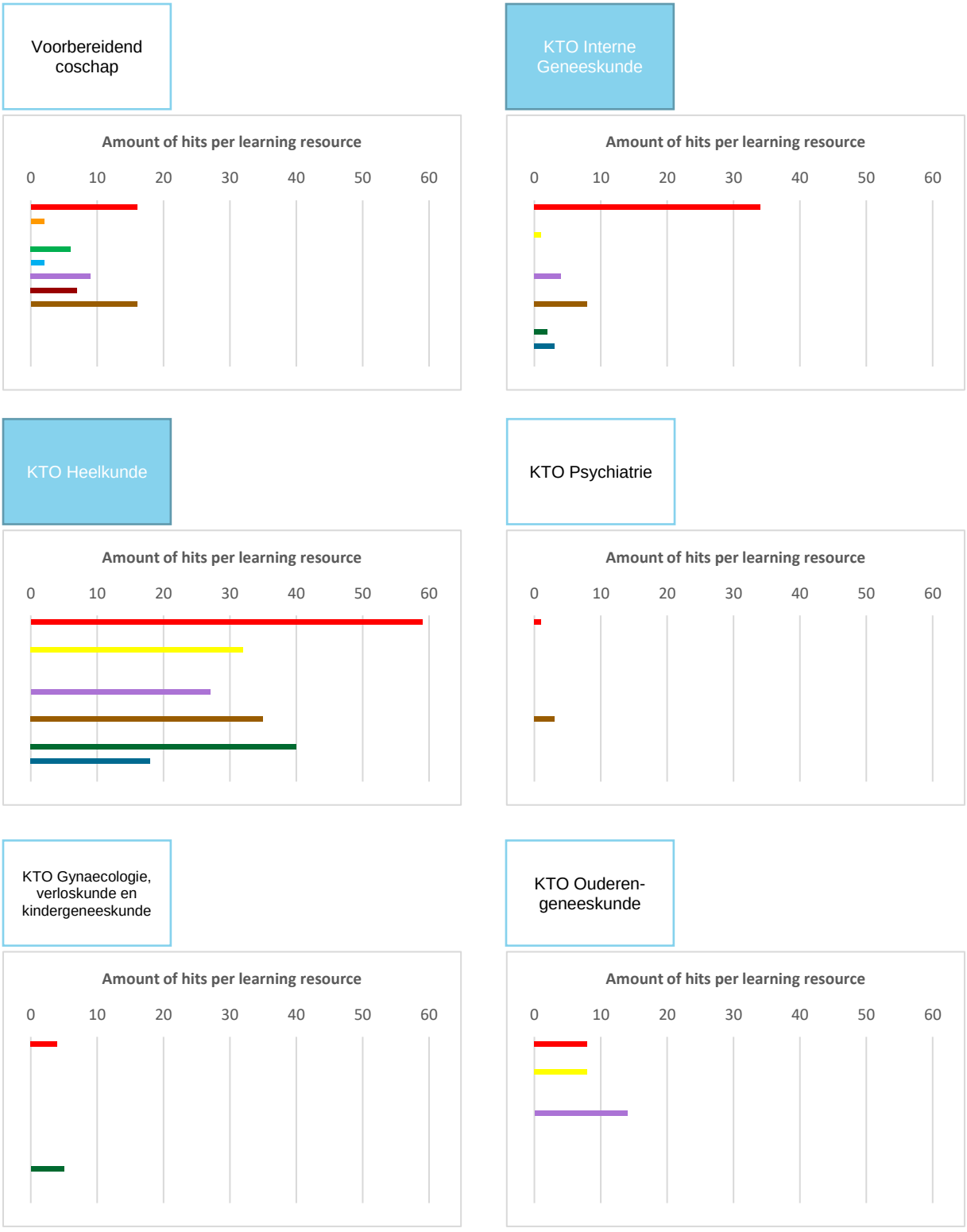


Figure A3 *The amount of hits per learning resource per course. Names of courses are displayed in Dutch.*

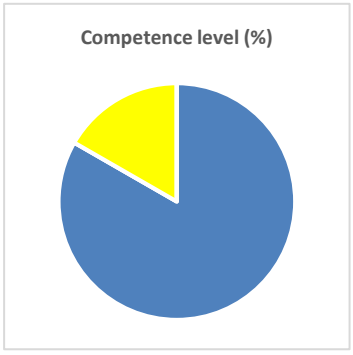
12 APPENDIX V: COMPETENCE LEVEL

LEGEND

- Remember
- Understand
- Apply

Arts en patiënt 1: Soma en psyche

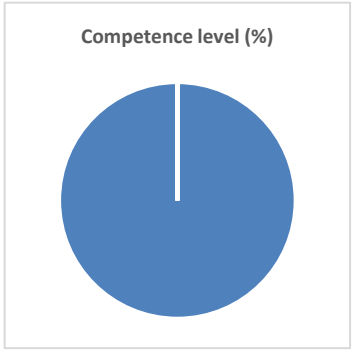
Homeostase



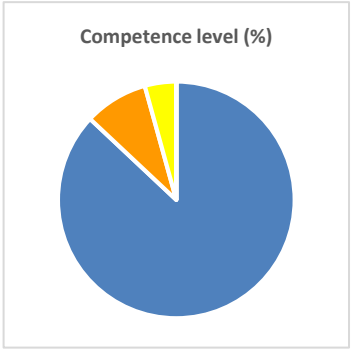
Schade, afweer en herstel

Arts en patiënt 3: Context

Sekse, seksualiteit en relaties



Spijsvertering en stofwisseling



Circulatie en vasculaire stoornissen

Figure A4 *The percentage of competence level per course. Names of courses are displayed in Dutch.*

13 APPENDIX VI: SIGNIFICANCE VALUES

Table A2 *Overview of the p-values of each comparison between the subcategories from the category 'drug group'. TAI = thrombocyte aggregation inhibitors; VKA = vitamin K antagonists; (LMW)H = (low molecular weight) heparins; DOAC = direct oral anticoagulants; Combi = combination of multiple drug groups.*

	TAI	VKA	(LMW)H	DOAC	Combi
TAI		0.229	0.781	< 0.001	0.117
VKA	0.229		0.250	< 0.001	0.012
(LMW)H	0,781	0.250		< 0.001	0.303
DOAC	< 0.001	< 0.001	< 0.001		< 0.001
Combi	0.117	0.012	0.303	< 0.001	

= significant difference; the category from the column has a higher error percentage than the category from the row

= significant difference; the category from the column has a lower error percentage than the category from the row

= no significant difference

Table A3 *Overview of the p-values of each comparison between the subcategories from the category 'subject'. IA = interaction; Ind = indication; MoA = mechanism of action; Anti = antidote; Prop = drug properties; Brid = bridging; Disc = discontinuation of drug; Plate = platelet life; Side = side effects.*

	IA	Ind	ADME	MoA	Anti	Dose	Prop	Brid	Disc	Plate	Side
IA		0.010	0.001	0.129	< 0.001	0.094	0.010	0.385	< 0.001	0.181	0.067
Ind	0.010		0.396	0.374	0.429	0.519	0.785	0.237	< 0.001	0.869	0.606
ADME	0.001	0.396		0.097	0.883	0.827	0.251	0.061	< 0.001	0.755	0.990
MoA	0.129	0.374	0.097		0.089	0.296	0.492	0.702	< 0.001	0.532	0.309
Anti	< 0.001	0.429	0.883	0.089		0.767	0.256	0.055	< 0.001	0.811	0.938
Dose	0.094	0.519	0.827	0.296	0.767		0.442	0.226	< 0.001	0.686	0.845
Prop	0.010	0.785	0.251	0.492	0.256	0.442		0.310	< 0.001	0.763	0.500
Brid	0.385	0.237	0.061	0.702	0.055	0.226	0.310		< 0.001	0.412	0.224
Disc	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001
Plate	0.181	0.869	0.755	0.532	0.811	0.686	0.763	0.412	< 0.001		0.805
Side	0.067	0.606	0.990	0.309	0.938	0.845	0.500	0.224	< 0.001	0.805	

= significant difference; the category from the column has a higher error percentage than the category from the row

= significant difference; the category from the column has a lower error percentage than the category from the row

= no significant difference

Table A4 *Overview of the p-values of each comparison between the subcategories from the category 'Bloom's taxonomy level'.*

	Remember	Understand	Apply
Remember		0.007	0.011
Understand	0.007		0.104
Apply	0.011	0.104	

= significant difference; the category from the column has a higher error percentage than the category from the row

= significant difference; the category from the column has a lower error percentage than the category from the row

= no significant difference

14 APPENDIX VII: STUDENT RESPONSES

An overview of all responses students gave when there was space to comment or further expand upon their answer option. Questions and answers are shown in Dutch.

Vraag 1 **Hoeveel tijd heb je ongeveer besteed aan het studeren voor deze toets?**
n.v.t.
Vraag 2 **Kies drie onderwerpen waar je de meeste tijd aan hebt besteed bij het studeren voor deze toets**
[Antidepressiva] omdat ik die nodig zou hebben hierna
Vraag 3 **Waarom heb je veel tijd besteed aan het onderwerp "Antistolling"? Je kunt meerdere antwoorden aankruisen.**
Ik vind het moeilijk om de verschillende indicaties te onthouden
Veel medicijnen en veel toepassingen
Het is veel omvattend + hoop interacties
Verschillende middelen en interacties
Veel medicatie mogelijkheden en werkingsmechanisme
Vraag 4 **Welke bronnen heb je gebruikt om te studeren voor het onderwerp "Antistolling"? Je kunt meerdere antwoorden aankruisen.**
RECIPE filmpjes
Filmpjes YouTube sectie farmaco VU
Mijn huisgenoot die er wel veel van af weet
Plexus app
Plexus app
Osmosis.org
Plexus app
5 oefentoetsen gemaakt
Geneesleer farmacotherapie boekje
App
Plexus
Oefentoets op canvas
Oefentoets
Al mijn eerdere kennis vanuit de bachelor en master
Youtube farmacotherapie
Youtube filmpjes
Eigen samenvatting van de bachelor
Vraag 5 **In welke mate voelde je je voldoende voorbereid op de vragen over het onderwerp "Antistolling" aan de hand van het antistollingsonderwijs? Geef dit een cijfer tussen de 1 en 5.**
Goed

Reeds bekend met antistollingsmedicatie
Voldoende info, duidelijke uitleg over indicaties en achterliggende pathofysiologie
De reader is duidelijk, daarbij kennis vanuit de praktijk
De reader gaf duidelijke en uitgebreide informatie
De basics zitten er in. Je begrijpt de stof meer, maar sommige vragen op de toets kunnen erg gedetailleerd of specifiek zijn
Het stond wel duidelijk in de reader, maar ik vond het nog steeds lastig om te onthouden
Super erg in op details en uit mijn hoofd geleerd
Veel informatie betreffende indicaties
Ik blijf het soms een onoverzichtelijk onderwerp vinden met alle verschillende indicaties. Het lukt me vaak niet om er een duidelijk overzicht van te maken
Het onderwerp is een breed onderwerp
Ik moest veel herkansen
Ik begreep eindelijk hoe het zat en kon goed beredeneren wanneer je welk medicament kan geven
Overlap in indicaties is niet helder uitgelegd
Soms raak ik het overzicht kwijt, daarom had ik zelf al eerder samenvattingen gemaakt omdat het soms zo verwarrend is (indicaties en controle APPT/trombocyten)
Door de reader had ik het idee dat ik het snapte
Geen flauw benul, is of lijkt lang geleden
Ik vond de vragen over interacties erg moeilijk en specifiek
Leerstof kwam overeen met tentamenvragen
Vind het het moeilijkste onderwerp en haal steeds alles door elkaar
Was wel weggezakt, een opfrisser was fijn geweest. Al biedt de reader ook voldoende info.
Ik vind het zelf een lastig onderwerp. Ik zou meer onderwijs over wensen
Blijft lastig onderwerp
Ik merkte dat mijn kennis steeds beter werd a.d.h.v. toetsvragen. Wat ik fout had zocht ik op. Blijft echter een lastig onderwerp.
Vooral in de bachelor aan de orde gekomen en bij chirurgie dus wel lang geleden
Toch soms een instinker zoals "welke indicaties"
Had tijdens ouderen een presentatie gegeven
3 jaar eruit geweest
Veel weggezakt
Kan de meeste vragen zonder twijfel beantwoorden, alleen indicaties haal ik soms nog door elkaar
Stof was duidelijk
Ik heb meer gehad aan zelfstudie
De e-reader bevatte compact en volledige de leerstof
Veel moest ik opnieuw leren uit de reader
Ik haal alles steeds door elkaar, lag meer aan mezelf dan de beschikbare info
Ik denk het echt goed te kennen, maar dat blijkt dan op de toets dit niet helemaal te zijn
Staat helder in de reader
Duidelijk, overzicht indicaties heeft voor mij veel geholpen
Het is zo lang geleden dat ik het moeilijk vindt om te zeggen hoeveel van mijn kennis voorkomtuit het onderwijs
Beetje theorie toets auto achtig
Onvoldoende geleerd. Niet per se het onderwijs niet goed genoeg is
Complex onderwerp en zakt snel weg, onderwijs al even geleden

Ik heb eerder het onderwerp antistolling goed voorbereid voor een KFR, dus dit was nog bekend. Mn. informatie over heparine was nieuw
Op het moment snapte ik het een beetje maar door het goed te kleren kwam alles samen en snapte ik het pas echt (onderwijs gaat soms ook wat snel)
Gewoon goed geleerd en begrepen
Gedurende de bachelor en master + de reader heb ik voldoende kennis opgebracht
In de master is relatief weinig onderwijs
Dmv casuïstiek in M1/M2 had ik er ook al veel over geleerd
Ik was zelfverzekerd dat ik de indicaties en verschillen tussen de antistollings medicatie kende
Door het leren wist ik precies de werking en indicaties
Vraag 6 **Welke onderdelen over het onderwerp "Antistolling" uit de Farmacotherapie Eindtoets Reader waren nieuw voor jou? Je kunt meerdere antwoorden aankruisen.**
Geen
Interactie vb: co-trimoxazol bij acenocoumarol
Niets van bovenstaande
Het was vooral best wel weg gezakt
Al eerder in de studie besproken
Mijn kennis over met name de farmacokinetiek en interacties was weggezakt
Dit was zo mooi duidelijk in de reader neergezet. Erg fijn
Zie eerdere toelichting
Weinig onderscheid in gemaakt (of opgemerkt door mijzelf) tijdens onderwijs
Deze onderwerpen zijn tijdens de lessen niet veel aan bod gekomen
Geen, info was alleen weggezakt
Geen, alles is ooit aan bod gekomen bij het onderwijs
Ik had het gevoel dat dit in de vorige versie minder duidelijk stond beschreven
De indicaties vind ik soms lastig te onthouden dus dat heb ik extra goed geleerd. Daarnaast wat je per antistolling in het lab moet controleren wist ik ook niet meer
De specifieke interacties moet je wel kennen, maar ik vind dat hier in de bachelor heel weinig aandacht aan is besteed. Ook interacties etc. vond ik hier moeilijk
Gebruik de reader ook vaak voor de FKR, waardoor veel onderwerpen niet nieuw zijn
Niets was nieuw, maar blijft altijd moeilijk
Had alles al wel eens gehoord tijdens de farmaco practica, behalve wat je moet doen bij problemen/bijwerkingen van antistolling
Niets nieuw, meer verdieping en details
Interacties tav CYP-enzymen
CYP/nierfunctiestoornis. Coupeer indicaties/bridging was weggezakt.
Geen
Veel bekende info was weggezakt
Lastig om dit te leren in 1 farmaco les, zelf er 2 middagen voor gaan zitten, werkt beter
Wellicht weggezakte kennis, maar ik heb hier meer aandacht aan moeten besteden
Ik kende alleen de middelen, buiten bloedingsrisico wist ik niets over interacties/risicogroepen
Indicaties vind ik het lastigste onderdeel
Kinetische gegevens was ik vergeten/niet bekend
Waren niet nieuw

m.n. rondom klaring en interacties met coumarines
Niks was nieuw, informatie was weggezakt door de jaren
Verschil tussen acenocoumarol + fenprocoumon, eigenschappen nadroparine, co-trimoxazol en VKA
Couperen van verschillende soorten antistolling
Vaak wel gewend om het in de praktijk te gebruiken, maar werkingsmechanismen relatief onbekend
Indicatie verschillen tussen DOACs en vit K antagonisten. Effect van nierfunctie op de antistolling. Manieren om te bridgen en couperen.
Geen. Ik heb het idee dat alles aan bod is gekomen.
Beleid bij ernstig bloeding
Ik wist nog niet van alle middelen het antidotum
Vraag 7 **Wat vond je van de moeilijkheidsgraad van de vragen over het onderwerp “Antistolling”?**
Op juist niveau maar wel moeilijk
Vraag 8 **Wil je nog iets anders kwijt over de farmacotherapie eindtoets of het farmacotherapie onderwijs? Dit mag in het algemeen of specifiek over het onderwerp “Antistolling”.**
Nee
Nee
Ik vond de toets, ondanks dat ik hem wel gehaald heb, een stuk moeilijker dan de oefentoets. Ook vind ik 2 farmaco toetsen tijdens 1 coschap te veel.
Misschien eerder in de opleiding/Master nog een keer goed college over indicaties etc. Vooral bij chirurgie/neurologie
Indicaties allemaal onthouden is niet nodig, snel op te zoeken in standaarden
Vraag 46: keuze voor DOAC i.p.v. clopidogrel is voor mij onduidelijk
Handige voorbereiding op FKR HAG
Nee
Te weinig voorbereiding
Bij onttrekkingsverschijnselen geef je toch lorazepam ipv oxa?
Ik vind de toets pittig. Heb 't kantje boord gehaald, maar we hebben ook nog een MKR en FKR, klinische les, presentatie en coschap. PS. Met pittig bedoel ik: strenge norm. Vragen zijn OK.
Reader en filmpjes op youtube waren handig
Een quiz of meer oefeningen
Ik zou graag wat meer farmaco onderwijs willen in de master, bijvoorbeeld met interactieve colleges zodat er iets meer herhaling is en je vragen kan stellen
T was pittig
Goed te doen. Wel goed lezen, daar zitten meeste fouten in
Te veel kinetiek
Momenten gedurende het co-schap waarin een oefentoets per onderdeel beschikbaar is (bv bij interne antistolling, bij chirurgie pijn, etc.)
X
Sommige dingen gaan iets te ver om naar te vragen, die zoeken alle artsen ook gewoon op
nvt
Onderwijsmomenten hebben bijgedragen aan het studeren. Er was al voorkennis

Erg slechte timing wegens drukte tijdens dit coschap. Ik heb hier super veel van geleerd, eigenlijk zouden ze dit tijdens VCP al moeten toetsen (betere voorbereiding op coschappen)
De reader is heel goed en duidelijk
Antistollingsonderwijs herhalen, VCP? Zakt nu heel erg weg. Onderwijsmoment voor eindtoets
De apps (met name Battle of the Meds) crasht super vaak, als hij het goed zou doen zou dat top zijn voor het oefenen
Nee
Meer onderwijs in de master
De medicatie opdracht van coschap oogheelkunde was erg waardevol, meer sortgelijk onderwijs zou ik zeker waarderen!