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RESEARCH ARTICLE

Added value of a competency-based subject catalogue for the first pharmacy state examination in Germany (P1): A survey conducted among pharmacy teachers at German universities

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Abstract

Background: The subject catalogue (SC) for the First State Examination in Pharmacy (P1) is a nationwide, concise list of subjects covered in the first two years of German pharmacy programmes. In its current form, however, it does not provide any information about the competencies to which knowledge of these subjects contributes. **Methods:** The subjects in this catalogue were mapped to competencies that are considered to be achievable within the first two years of the curriculum. On the basis of this draft competency-based catalogue, we conducted an online survey of pharmacy faculty at German universities on the added value of a competency-based SC. **Results:** On average, about 75% of the participants (*N* = 158) agreed or partly agreed with the assumptions made in this survey about the benefits of a competency-based SC. Non-professors and younger teachers are generally more open to the concept than full professors and more experienced teachers. Professors, in particular, expressed their fears of regimentation and infringement of their freedom of teaching. **Conclusion:** The attitude of the participating German pharmacy teachers towards a competency-based SC is predominantly positive. Many points of criticism could be addressed in a participatory process of SC development.

Introduction

The German university pharmacy programme is a four-year curriculum taught at 22 Universities that focuses on scientific (drug-oriented) rather than clinical (patient-oriented) aspects of pharmacotherapy (Baecker *et al.*, 2022). It has five core pharmaceutical disciplines: Pharmaceutical and Medicinal Chemistry, Pharmaceutical Biology and Pharmacognosy, Pharmaceutics, Pharmacology and Toxicology, and Clinical Pharmacy. The scientific foundations of these disciplines are taught in the first two years after which the First State Examination in Pharmacy (P1) is taken to ensure a national standard of basic scientific knowledge. P1 is held simultaneously at several locations throughout the country and consists of four single-choice item tests prepared by the German Institute for State Examinations in Medicine, Pharmacy, Dentistry and Psychotherapy (IMPP), covering the following disciplines:

- General, Inorganic, and Organic Chemistry
- Pharmacognosy and Human Biology
- Physics, Physical Chemistry, and Basic Pharmaceutics
- Pharmaceutical Analysis

The subjects tested in these examinations are listed in Annex 13 of the German Pharmacist Licensing Regulations (AAppO) (BMG, 1989) and, in more detail, in the Subject Catalogue (SC) for the P1 examination (IMPP, 2019). This SC is organised into subjects and subject areas in which examination content is hierarchically assigned (classical syllabus format). This

differs in some respects from the requirements of the European Qualification Framework (EQF), which represents a paradigm shift from content-based (teacher-centred) education to outcome-based education (Cedefop, 2011). In higher education, the implementation of the EQF was accompanied by an obligation to include the intended learning outcomes in the module handbooks for Bachelor's and Master's programmes as operationalised learning objectives, i.e., a knowledge component and a process component (the desired behaviour) combined in a complete sentence with subject, predicate, and object (Mager, 1997), rather than keyword-based syllabuses.

In Germany, different from most European countries, specific programmes that qualify for systemically relevant professions such as medicine and pharmacy, conclude with a state examination instead of a Bachelor's or Master's degree. Some of these programmes are not subject to the EQF and have escaped the above-mentioned transformations. Nevertheless, in medicine and dentistry, for example, standardised national competency-based catalogues of learning objectives for undergraduate medical education (NKLM) and dental education (NKLZ) were developed (Fischer *et al.*, 2015; MFT, 2015a, 2015b, 2021), followed by a competency-based SC for state examinations in medicine (IMPP, 2020, 2021). Although it is challenging to transfer experience with competency-based education from medicine to pharmacy education even in countries with a much stronger emphasis on clinical aspects in their curricula than in Germany (Austin *et al.*, 2023), the Federal Union of German Associations of Pharmacists (ABDA) has published a catalogue of learning objectives that are mapped against pharmaceutical competencies (BAK, 2017). Similar to competency standards frameworks previously published in other countries (Medina *et al.*, 2013; RPS, 2013; NAPRA, 2014; Pharmacycouncil, 2015; BAG, 2016; PSA, 2016; FIP, 2020; PSI, 2022), this catalogue focuses on roles and responsibilities of practitioners (mainly in retail pharmacies) and does not cover other areas of pharmaceutical activity, such as industry or research. On this matter, the divisions of the German Pharmaceutical Society (DPhG) have published a series of statements on pharmaceutical competencies from a scientific perspective (Alban *et al.*, 2017; Biel *et al.*, 2017; Bunjes *et al.*, 2017; Clement *et al.*, 2018; Friedrich *et al.*, 2018; Ritter, 2018; Laufer *et al.*, 2019).

The qualification objectives and the teaching content of the German pharmacy programmes are summarised on the website of the Association of German Pharmacy Professors (VdPPHI, 2020a, 2020b). Learning objectives in this list are not (yet) operationalised in a competency-based manner.

Despite the advantages of operationalised learning objectives for the constructive alignment in curriculum development (Biggs, 2003), their added value in subject catalogues for state examinations, and the influence of a competency-based SC on teaching, is less obvious, as is the attitude of German pharmacy educators towards outcomes-based education in general. Personal conversations suggest that the community is divided on this subject: while many colleagues from the natural sciences are traditionally more sceptical and prefer to stick to content-based education, clinical pharmacists, for example, seem to be more open. However, as perceptions depend on who you talk to, and there are also widespread misconceptions about what is meant by the term 'competency-based' in pharmacy education (Nash *et al.*, 2015; Rhoney & Meyer, 2024), from personal experience alone, no conclusions can be drawn about the general attitude of German pharmacy teachers. This highlights the need to finally replace conversation-based assumptions with empirical, ideally representative, data on the attitudes of pharmacy teachers towards competency-based education.

The aim of this study was to obtain such data, here in the context of a possible transformation of the SC of P1 from a classical syllabus format to a competency-based format. To achieve this, we conducted an online survey of pharmacy educators from all German universities with a pharmacy degree programme to find out their views on the potential benefits of a competency-based format and their preferences for design and layout.

Methods

Preparation of a competency-based draft catalogue

Due to the survey participants' potentially very different ideas of what a competency-based SC might look like, a draft was prepared to serve as a standardised basis for discussion in this survey. To develop this draft proposal, subjects and subject areas of the 5th edition of the SC for P1 were replaced by operationalised learning objectives, which are competencies that, in our opinion, can be expected from pharmacists at the end of their first two years of study. To verify the validity of these competencies, 31 pharmacy professors (all contracted by the IMPP as experts in the disciplines examined in P1) were asked to review and comment on chapters and subchapters of their respective specialty in a digital review form. The competencies were revised according to the comments from 27 returned forms. In addition, the

draft SC was sent to pharmacy students recruited through the Federal Association of Pharmacy Students in Germany (BPhD), who suggested application examples and examples of related third and fourth-year content of the German pharmacy curriculum. The students' suggestions were incorporated into the draft after careful review and editing.

Anonymous online survey

An online questionnaire was designed in LimeSurvey (LimeSurvey GmbH, Hamburg, Germany) with 40 items including 17 four-point Likert scale items, 11 closed questions (5 single-choice, 2 multiple-choice, 4 yes/no), open-ended questions (11 free text fields), and 1 ranking item (Appendix A). Six of these items (1 single-choice, 1 multiple-choice, 4 free text fields) were only accessible for the purpose of specifying an answer to a previous closed question. The sections of the questionnaire can be divided into questions about status and role as a university teacher as well as subject and age (7 items); qualification in university didactics and use of operationalised learning objectives in teaching (8 items); assessment of the added value of a competency-based subject catalogue for teachers and students respectively (8 items); questions about preferences for the design and layout of the subject catalogue and its online version (12 items); criticism and suggestions (5 items). Attempting to reach all German pharmacy educators, an invitation to participate in the online survey, together with a short cover letter describing the purpose of the study and assuring anonymity and confidentiality, was sent via e-mail to 441 pharmacy teachers (full professors, lecturers, assistant professors, junior group leaders, etc.) identified from the institutional websites of all 22 German universities with a pharmacy programme. The recipients were encouraged to forward the invitation to colleagues. The draft proposal was made available for download via a web link within the online survey for those who participated in the survey. The survey was conducted between 21 December 2022 and 31 January 2023. Two reminder emails were sent in intervals of two weeks. The questionnaire was completed by 158 participants (36 % of those invited). Responses from non-completed questionnaires were ignored. As our survey was completely anonymous and individuals were not identifiable, the study was considered exempt from ethical review.

Statistical analysis

Descriptive statistics and explorative data analysis were applied on the quantitative responses from closed questions and four-point Likert scales to show possible correlations between categories either by calculation of Spearman's rank correlation coefficient ρ (with one-sided Student's t-test for significance) or by calculating a p-value according to Pearson's X^2-test in SPSS (IBM, Ehningen, Germany).

The responses to four-point Likert scale questions were visualized as stacked bar plots in Origin (OriginLab, Northampton, MA, USA), where percentages correspond to Likert scale ratings or averaged ratings from four questions.

The score S for measuring the participants' preference for a particular design was calculated from the number of choices for a particular rank N_{rank} and a weight for each rank (4 for rank 1, 3 for rank 2, 2 for rank 3, 1 for rank 4) as:

$$S = N_{\text{rank 1}} \cdot 4 + N_{\text{rank 2}} \cdot 3 + N_{\text{rank 3}} \cdot 2 + N_{\text{rank 4}} \cdot 1$$

Responses in text fields were grouped into categories (see main text) and counted as follows: if different categories were addressed in a single text field, it was counted as a text contribution to each of the categories addressed; if the same category was addressed in different text fields by the same individual, they were counted as a single text contribution.

Results

A draft of a competency-based SC for P1

To illustrate a possible competency-based SC for P1, subjects belonging to the same topic were mapped to generalised target competencies that apply to the whole group of thematically related subjects (Table I). These target competencies, expressed as operationalised learning objectives, were selected according to two criteria. Firstly, the competency, whether knowledge-based or practical, had to be achievable within the first two years of the programme. Secondly, the subjects listed under such a competency and assessed in the knowledge-based exam would make an important contribution to the achievement of these second-year milestone competencies.

In this draft SC, we refrained from operationalising each subject individually for two reasons. Firstly, to date there is no fully operationalised catalogue of learning outcomes in German pharmacy education. Without such a wider context, the operationalisation of individual subjects according to commonly used taxonomies of educational objectives (Morshead *et al.*, 1965; Miller, 1990; Krathwohl, 2002), would be limited to competencies such as 'remember', 'recognise', etc., which would add little information value compared to

non-operationalised subjects. Secondly, the content of the previous edition of the SC had to be kept as recognisable as possible, as only the change in format was to be assessed in this survey. Since operationalised learning objectives in complex subject areas are generally difficult to master, we felt that the SC written in a hybrid format would better serve its purpose and be easier and quicker for survey participants to understand.

Table I: Comparison between a subject-based SC and our proposal for a competency-based SC (with application examples) presented as a draft to be evaluated in this survey, for a topic from the chapter "General, Inorganic and Organic Chemistry"

Subject-based	Competency-based	
Discipline **Organic chemistry**		**'What for' (applications)**
Topic **1.3.2 Chemical bonding**	*They can explain binding models and assess the reactivities of organic compounds as well as intra- and intermolecular interactions. They can plan simple (single-step or short multi-step) organic syntheses.* ***For this purpose, they apply knowledge about:***	Fundamentals of organic chemistry, drug synthesis; reactivity of functional groups; stability of compounds; solubility; chromatographic and spectroscopic methods; melting and boiling points; structure of proteins and DNA
Objectives **1.3.2.1 Models of chemical bonding** Atomic and molecular orbital models, orbitals, hybridization of orbitals, VB and MO theory, HOMO and LUMO. **1.3.2.2 C,H-, C,C- and C,heteroatom single bonds** Bonding parameters, polarity, spatial structure		

Participants and their didactic knowledge

The online questionnaire was completed by a total of 158 participants from all pharmaceutical disciplines (Medicinal Chemistry, Pharmaceutical Biology, Pharmaceutics and Biopharmacy, Pharmacology and Toxicology, Clinical Pharmacy, other subjects such as those taught by teachers not affiliated to a pharmacy department; Figure 1A). These included full professors (50.0 %), adjunct professors (8.9 %), lecturers (24.7 %), and junior group leaders (5.1 %). Participants designated as 'other' (11.4 %) were research assistants (some with permanent contracts), postdocs (some leading a junior research group) and teachers from other institutions teaching in the pharmacy programme (Figure 1B). Of the total of 158 teachers, 26 (16.5 %) stated that they hold a higher education (HE) didactics certificate. About half (82; 51.9 %) had taken part in a university didactics training programme at least once (see Figure 1C for participations per topic), in some cases several times. Of these, 48.8 % had dealt with learning objectives as part of such training.

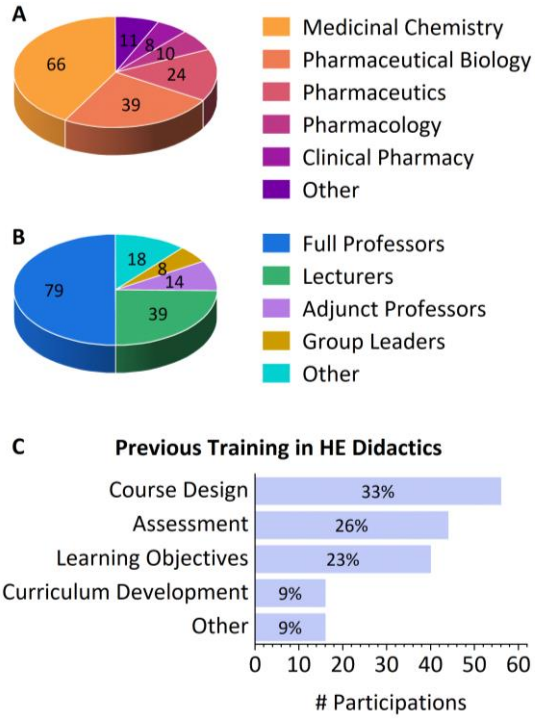

Figure 1: Participants who completed the entire survey (*N* = 158). A: Number of participants by pharmaceutical discipline. B: Number of participants by status group. C: Participation (by topic) in higher education (HE) didactic training events (a total of 172 participations by 82 people).

An overwhelming majority (95.6 %) of pharmacy lecturers specify learning outcomes in their courses at least occasionally (49.4 % always do), whereas operationalisation of learning objectives appears to be largely absent: only 20.0 % state that they operationalise learning objectives; 63.6 % are not familiar with the term 'operationalisation of learning objectives' at all. The proportion of those who are unfamiliar with the concept of learning objective operationalisation is slightly lower among those who have taken part in further training in HE didactics than among colleagues who have not (57.0 % compared to 70.8 %). The term is much more familiar to those who hold an HE didactics certificate (only 36.0 % of 25 people with a certificate who use learning objectives are not familiar with the term).

Added value of a competency-based subject catalogue

Added value for teachers from the teachers' perspective

In the survey, an assessment was to be made of four statements on the possible added value of a competency-based subject catalogue in comparison to a subject-based SC for teachers (Table II).

The approval ratings were quite similar to all four statements with slight fluctuations in the different categories. Participants tend to a higher agreement with statements aimed at a purely pragmatic use of the competency-based SC: the statements 'can serve as a template for learning objectives in class' and 'can serve as a template for the publication of learning objectives (web site, module handbooks, etc.)' both achieved >29 % full agreement. For the latter, there is a significant correlation between the ratings and the answer to the question of whether own learning objectives are operationalised ($p = 0.003$ (X^2)).

The participating teachers largely agree that by referring to targeted skills, a competency-based SC provides better guidance in selecting and designing course content. This hypothesis is particularly well supported by non-professors (53.2 % partially agree; 31.6 % agree) and slightly less by full professors (49.4 % partially agree; 12.7 % agree). The assumption that the competency-based SC provides a guideline for the alignment of teaching with examination objectives of P1 is largely agreed with by the total of participants, but met with scepticism in the group of full professors (34.2 % partially disagree and 12.7 % disagree).

Table II: Assessment of hypothetical benefits of a competency-based SC for teachers (from the teacher's point of view)

Hypothetical benefit	Rating			
	Agree	Partially agree	Partially disagree	Disagree
Helps with selection/design of teaching content	22.2 %	51.3 %	15.2 %	11.4 %
Provides a guideline for the alignment of teaching with examination	23.4 %	44.9 %	22.2 %	9.5 %
Can serve as a template for learning objectives in class	21.1 %	51.9 %	13.3 %	5.7 %
Can serve as a template for the publication of learning objectives (web site, module handbooks, etc.)	29.7 %	46.2 %	15.8 %	8.2 %

As a general measure of attitudes towards a competency-based SC, means of agreement ratings were calculated and analysed for different sub-populations (Figure 2).

According to the general approval ratings (sum of 'agree' and 'partially agree'), around three quarters agree with the assumption that a competency-based SC provides added value for teachers compared to a subject-based SC (Figure 2A). General scepticism, expressed as the sum of 'partially disagree' and 'disagree', is significantly higher (around twice as high) among full professors than among non-professors (Figure 2A). A similar picture emerges from a comparison of different age groups. While less than 15% of teachers aged 30–44 have general doubts about the benefits of a competency-based SC, the number of sceptical teachers in the 45–59 age group is more than twice as high (Figure 2B; note that each age group includes both full professors and non-professors). For those over 60, scepticism decreases slightly in favour of higher scores for the 'partially agree' category (faculty under 30 did not participate in the survey).

The ratio of agreement to scepticism ranges from 70:30 to 77:23 between the pharmaceutical disciplines, with fluctuating mean values of the categories. (Figure 2C). Due to the quite different evaluation of the four statements by Pharmaceutics teachers (for example, higher agreement with the statement 'can serve as a template for learning objectives in class' than with 'helps with selection/design of teaching content'), the standard deviations of the mean values for 'partially agree' and 'partially disagree' in this sub-group are

noticeable. However, given the small number (N = 24), these trends are not necessarily representative for Pharmaceutics teachers in general. Interestingly, the mean ratings of the 'Pharmaceutical and Medicinal Chemistry' subpopulation (N = 66) correspond almost exactly to those determined for all participants in total (N = 158).

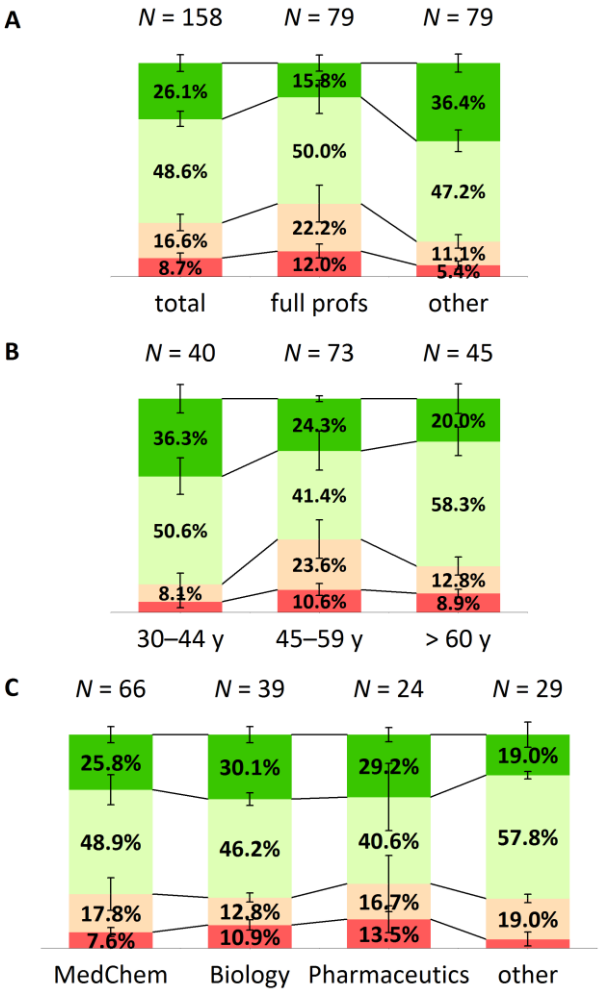

Figure 2: Mean ratings of pharmacy faculty on the four assumptions from Table II on hypothetical benefits of a competency-based SC for teachers (error bars indicate the standard deviations of the four ratings). A: by status group; B: by age group; C: by discipline. Legend: ■ agree; ■ partially agree; ■ partially disagree; ■ disagree with the importance of a particular feature; full profs: full professors; y: years; MedChem: Medicinal Chemistry

No significant correlation was found between the ratings of the statements in Table II and previous didactic training such as participation in HE seminars (p-values (X^2) between 0.817 and 0.893), except for the assessment of the statement that a competency-based SC 'can serve as a template for learning objectives in class', which depends on whether or not one holds an HE didactics certificate (p = 0.060 (X^2)).

Added value for students from the teachers' perspective

Teachers were also asked to assess four assumptions about benefits for students from a competency-based SC (Table III).

A large majority (>80%) agrees or partially agrees with the statement that a competency-based SC better illustrates the relevance of the examination content for pharmaceutical education than a subject-based SC. The participants are somewhat more sceptical towards the other three assumptions. In particular, almost 10 % fully disagree with the statement that the motivation to learn would be increased by showing application examples. Although the respondents rated the assumption 'creates links with later study content and applications that build on the first state examination' almost identically, there is no significant correlation between the response behaviour to these two assumptions (p = 0.649 (X^2)).

On average, almost three quarters of lecturers agree with the general assumption that a competency-based SC offers added value for students compared to a subject-based SC (Figure 3A). Like above (Figure 2), the general scepticism towards the assumption of added value for students is significantly greater among professors than among non-professors (Figure 3A). The proportions between the two positive ('agree' and 'partially agree') and the two negative ('partially disagree' and 'disagree') categories vary across the different age groups, with the 30–44 age group standing out with the highest values for 'agree' and the lowest values for 'disagree' (Figure 3B).

Medicinal chemists and pharmaceutical biologists gave the highest level of full agreement to the statements in Table III (>28 %). The highest scepticism (sum of the ratings for the categories 'partially disagree' and 'disagree') was observed among Medicinal Chemistry and Pharmaceutics teachers (around 30 %).

The assessment of 'increases motivation to learn by demonstrating applications', an assumption particularly controversial among Pharmaceutics teachers (42 % partially disagree or disagree), correlates moderately with participation in didactics training (p = 0.132 (X^2)) and with possession of a HE didactics certificate (p = 0.155 (X^2)) and significantly with the answer to the question of whether one's own learning objectives are operationalised (p = 0.026 (X^2)).

Table III: Assessment of hypothetical benefits of a competency-based SC for students (from the teacher's point of view)

Hypothetical benefit	Rating			
	Agree	Partially agree	Partially disagree	Disagree
Illustrates the relevance of examination content	32.9 %	51.3 %	8.9 %	7.0 %
Informs about expected depth on what students are expected to know and how knowledge can be applied	28.5 %	42.4 %	22.8 %	6.3 %
Creates links with later study content and applications that build on the first state examination	18.4 %	54.4 %	20.9 %	6.3 %
Increases the motivation to learn by showing applications	17.7 %	51.3 %	21.5 %	9.5 %

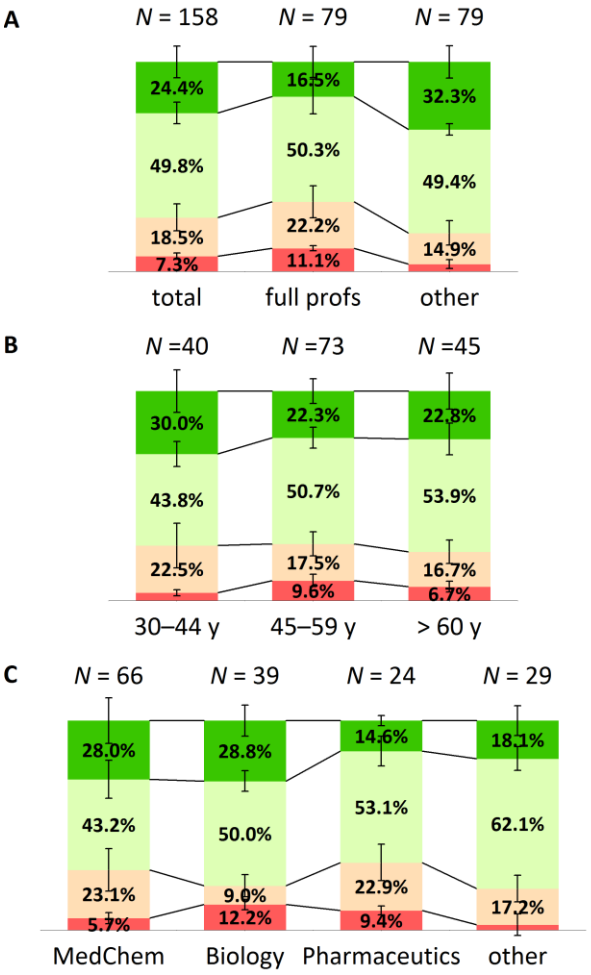

Figure 3: Mean ratings of pharmacy faculty on the four assumptions from Table III on hypothetical benefits of a competency-based SC for students (error bars indicate the standard deviations of the four ratings). A: by status group; B: by age group; C: by discipline. Legend: ■ agree; ■ partially agree; ■ partially disagree; ■ disagree with the importance of a particular feature; full profs: full professors; y: years; MedChem: Medicinal Chemistry.

Design and implementation

Participants were asked to rank four different designs of a competency-based SC (Appendix A) according to their personal preference. From their ranking, a score *S* was calculated (see Methods), according to which the most popular proposal was example 4, followed by example 2 and example 3; example 1, a purely competency-based catalogue with no thematic section headlines at all, came last (Appendix B).

They also rated the importance of four different properties of design, layout, and outline of the SC, namely the importance of clear hierarchical structure, conciseness, preciseness of the formulation of learning outcomes, and additional information such as competency levels or applications, with a four-point Likert scale (Table IV).

An overwhelming majority considered a clear hierarchical structure an important feature. Not surprisingly, the ratings of the importance of detailed and precise learning objectives and the importance of a short catalogue correlate inversely: those who prefer a short SC would do without precise learning objectives and vice-versa (ρ = −0.107; t = 0.09). There is also an inverse correlation between the preference for conciseness and the ratings of the potential benefits of a competency-based SC for teachers and students, particularly of the assumptions that it 'helps with selection/design of teaching content' (ρ = −0.15; t = 0.03) and that it 'can serve as a template for learning objectives in class' (ρ = −0.133; t = 0.047). The importance of the accuracy of learning objectives, on the other hand, correlates inversely with age (ρ = −0.214; t = 0.004). These correlations suggest that there are basically two groups of respondents: those who feel that the disadvantage of increased length is outweighed by the opportunities for teachers and students that a competency-based SC offers, and those for whom the added value is less obvious and who therefore prefer a concise SC. Those in favour of a concise SC belong predominantly to the group of

professors (p = 0.035 (X^2)). Interestingly, the members of this group do not generally reject the formulation of learning objectives, as many of those in favour of a concise SC stated that they formulate learning objectives themselves in their courses (significant correlation; p = 0.018 (X^2)).

Finally, around two thirds of pharmacy teachers would like the learning objectives to be made more precise by providing additional information (labelling of competency levels, application examples; Table IV). Those who would rather do without such additional information are predominantly professors (significant correlation with status; p = 0.003 (X^2)).

While the availability of a printable format such as PDF is still appreciated (45.6 % full agreement), the participants recognise the potential of a digital online format (Table IV). More than 80 % would welcome the ability to navigate through hierarchical levels and to jump between related or connected learning objectives via links. The option to switch between different representations of the SC with different levels of detail, on the other hand, is considered less important or unimportant by a majority. It is noticeable that the preference for features such as detailed and precisely formulated learning objectives, indication of competency level through application examples, and navigation through hierarchy levels by mouse click correlates highly significantly with agreement with all assumptions on added value for teachers and students (p < 0.001 (X^2)).

Table IV: Assessment of the importance of different properties of design, layout and outline as well as of features of the digital online-version of the SC

Property/feature	Rating of importance			
	Agree	Partially agree	Partially disagree	Disagree
Design, layout, outline				
Clear hierarchical structure/organisation	41.1 %	44.9 %	12.0 %	1.9 %
Conciseness	31.0 %	39.2 %	24.7 %	5.1 %
Detailed and precise learning objectives	33.5 %	38.0 %	22.8 %	5.7 %
Additional information for specification of learning objectives (competency levels, application examples, etc.)	24.7 %	44.3 %	20.3 %	10.8 %
Digital online-version				
One-click navigation through the hierarchy levels	38.6 %	42.4 %	11.4 %	7.6 %
Possibility to choose between different representations (e.g. as in examples 1 to 4)	10.1 %	35.4 %	38.6 %	15.8 %
Connection of related learning objectives via links	33.5 %	38.0 %	22.8 %	5.7 %
Provision of a printable version (PDF) in the style of previous bound editions of the SC alongside the digital version	45.6 %	21.5 %	19.6 %	13.3 %

Critical comments

The survey participants were given the opportunity to express their reservations about a competency-based SC in free text fields. These critical comments (74 in total) could be roughly categorised into six different aspects (Figure 4A). 48 of these critical comments came from professors, 26 from the other status groups surveyed (Figure 4B).

A concern expressed by 12.7 % of the survey participants (20 comments) is that the explicit listing of competencies and learning objectives further reinforces the regimentation of pharmacy studies and could give the impression that anything not listed in the catalogue is not relevant. While this criticism seems to be directed against the idea of listing examination tasks in the form of a catalogue in general, some fear that the explicit definition of the desired competency levels would restrict flexibility in teaching, including a possible legal obligation to comply with the competency levels defined in the SC. Furthermore, as regimentation fundamentally contradicts the basic idea of university teaching, a competency-based SC might lead to a decrease in the independence and critical thinking of pharmacy students.

Nine commentators (all professors) interpret a competency-based SC as an encroachment on the freedom of teaching. Some questioned the appropriateness of the P1 SC containing references to the content of the third and fourth year of the programme, which is not the responsibility of the IMPP issuing the SC.

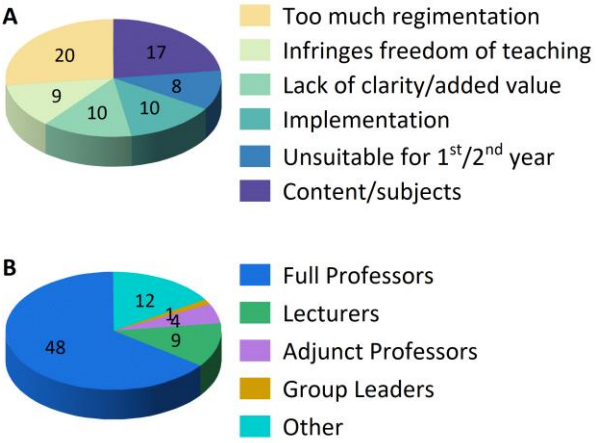

Figure 4: Numbers of critical comments from free text fields. A: Number of comments grouped by aspects to which critical comments can be assigned. A: Number of comments per status group.

Ten commentators fear a loss of clarity in the catalogue, as the inserted learning objectives distract from the actual content. In their opinion, a keyword-based SC is self-explanatory with regard to the desired competencies. Teachers should be able to formulate learning objectives in class themselves, so that no added value is created by learning objectives in the SC.

Ten participants criticised the way learning objectives were implemented in the draft SC. Some comments expressed the misconception that the presentation of application examples, which are mainly third- and fourth-year content, created an obligation to teach them in the first and second year in preparation for P1. Other comments criticised the selection and prioritisation of the operationalised learning objectives.

In 8 comments, a competency-based catalogue was considered unsuitable for the first two years of the German pharmacy degree programme, as the competencies taught and tested are mainly basics and factual knowledge. This could inadvertently put more pressure on students, as the additional information may make it less clear what is expected of them. Interestingly, in the 1970s, a similar criticism was made of the then competency-based SC medicine: students might feel overwhelmed and demotivated by learning objectives that were formulated far too ambitiously (Duppré, 1976).

The remaining 17 comments criticised outdated and unbalanced content. The desire for more frequent revision of subjects was expressed several times. In a concluding yes/no question, 57.0 % of respondents indicated their willingness to contribute to the continuous development of the SC in an online-based SC development process.

Discussion

On average, three-quarters of respondents believe that the assumptions about the added value for teachers are mostly true. The group of professors is somewhat more reserved; nevertheless, even in this group the proportion of full agreement is on average higher than the proportion of full disagreement. Free text comments suggest that particularly professors are concerned about maintaining the autonomy of teaching. Another caveat is that the learning objectives of the first two years of pharmacy education should be obvious and therefore can be assumed to be intrinsically known. The high level of agreement of non-professors with the assumptions about added value may be due to the fact that a significant proportion of P1 content is deepened in seminars and laboratory courses, which are predominantly taught by mid-level academic staff.

Another striking finding is the decreasing agreement with assumptions about benefits of the competency-based SC among the over-45s. This is in line with previous reports from other fields about an increasing reluctance to embrace innovative approaches to teaching with increasing teaching experience (Khalaily, 2019). Differences between the pharmaceutical disciplines should not be over-emphasised considering the small sub-populations. However, it is noticeable that Pharmaceutics teachers see the added value of a competency-based SC mainly in its use as a template for formulating learning objectives.

Although less consistent on individual statements, the mean ratings of the respondents as a whole and of the status and age subpopulations on added value for students are similar to those for the statements on added value for teachers.

Those who rated the assumptions on benefits in the ‘disagree’ category (between 5 and 10 %) may rule out any added value of a competency-based SC or may even prefer not to specify learning objectives in teaching at all (4.4 % reported that they do not specify learning objectives in teaching). Concerns expressed in free text fields, that detailed specification of learning objectives in a subject catalogue would encourage further regimentation of pharmacy education, appear to reflect a fundamental reservation of a group of pharmacy educators about the concept of outcomes-based education. Such considerations, although less relevant in the context of P1, are consistent with the criticism expressed elsewhere that the ‘critical thinking’

competency taught in traditional university teaching cannot be represented by measurable learning outcomes (Erikson & Erikson, 2019).

Some respondents questioned the appropriateness of using operationalised learning objectives for the content of the first two years of the programme. In the international context of pharmacy, competency catalogues are usually frameworks of competencies required of practitioners published by authorities or professional bodies (RPS, 2013; NAPRA, 2014; Pharmacycouncil, 2015; PSA, 2016; FIP, 2020; PSI, 2022), some of which are designed as catalogues of the desired learning outcomes for national pharmacy programmes (Medina *et al.*, 2013; BAG, 2016; BAK, 2017). Ideally, an examination to assess the learning outcomes that qualify for the competencies listed in such catalogues is taken at the end of the pharmacy curriculum or, depending on a country's licensing regulations, after pre-registration training. In contrast, according to German licensing regulations (BMG, 1989), P1 is an examination that students must pass in order to continue their curriculum. As a knowledge-based examination, it does not reflect all the learning objectives covered in the first two years. Nevertheless, the knowledge assessed in P1 contributes to the milestone objectives of the second year. Therefore, the competency-based SC is intended to demonstrate how P1 aligns with the desired learning outcomes after the second year of the curriculum (Biggs, 2003). In the context of a catalogue of learning outcomes such as those quoted above, it can be seen as a specification of the 'Foundational Knowledge' domain.

The authors believe that alignment with such milestone objectives can assist in the revision of the SC content and the selection of P1 test items of appropriate difficulty in relation to the desired outcome. Future versions of a competency-based SC will need to make this purpose clearer.

By the numbers, application examples are largely welcomed. Accordingly, a majority of pharmacy teachers favour a design that includes such examples.

Limitations

A limitation of this study is that, despite the response rate of 36 % with respect to the number of invitations is in the upper range of what is usually achieved in surveys, it may still not be representative.

Conclusion

With regard to the design of a competency-based SC presented in this survey, the added value that could result for teachers and students was assessed positively by the majority across all sub-groups. We interpret concerns about interference with teaching autonomy and the criticism of the content of the SC as a strong desire for a wider involvement of all teachers in SC development, also reflected in the broad willingness to voluntarily participate in an online process for the continuous development of the SC (57.0 %). This could be carried out in a crowd-based process similar to the one previously used for the transformation of the medicine SC to an outcome-based format (IMPP, 2020, 2021) to ensure the broadest possible consensus among pharmacy faculty.

Conflict of interest

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Appendix A: Questionnaire (German was used in the online survey; for English translation see below)

Questions about the participant

1. Which category best describes your status? (select one)
   - full professor
   - adjunct professor
   - group leader
   - lecturer
   - other

1a. If you selected “other”: What best describes your status? (free text)

2. What age group do you belong to? (select one)
   - 29 or younger
   - 30-44
   - 45-59
   - 60 or older

3. What type of course do you teach/supervise? (multiple choice)
   - lecture
   - seminar
   - laboratory course
   - other

3a. If you selected “other”, please specify (free text)

4. What is your pharmaceutical discipline? (select one)
   - Medicinal Chemistry
   - Pharmaceutical Biology
   - Pharmaceutics
   - Pharmacology
   - Clinical Pharmacy
   - other

4a: If you selected “other”, please specify (free text)

Qualification in university didactics

5. Have you ever taken part in university didactic training?
   - yes
   - no

5a. If you selected “yes”, please specify (multiple choice)
   - curriculum development
   - course design
   - learning objective
   - assessment
   - other

5b. If you selected “other”, please specify (free text)

6. Do you hold a higher education didactics certificate in accordance with the standards of the German Society for University Teaching (e. g. certificate for university teaching of a Bundesland) or a comparable additional teaching qualification?
   - yes
   - no

Operationalised learning objectives

7. Do you present the learning objectives of your own courses to students? (select one)
   - always
   - occasionally
   - never

7a. If you have selected “always” or “occasionally”: Are your learning objectives operationalised? (select one)

- yes
- no
- I am not familiar with the term “operationalisation of learning objectives”.

7b. If you have selected “yes”: Could you give an example of an operationalised learning objective from one of your courses (free text)?

8. Do you think that defining learning objectives can increase the success of a course? (select one category)
   - agree
   - partially agree
   - partially disagree
   - disagree

Hypothetical benefits of a competency-based subject catalogue for teachers

If you are interested, you can take a first look at what a competency-based catalogue might look like by clicking below:

- general, inorganic, and organic chemistry
- pharmacognosy and human biology
- physics, physical chemistry, and basic pharmaceutics
- pharmaceutical analysis

9. For teachers, the added value of a competency-based subject catalogue over the current keyword-based subject catalogue is that it...

9a. …helps with selection/design of teaching content. (select one category)
   - agree
   - partially agree
   - partially disagree
   - disagree

9b. …provides a guideline for the alignment of teaching with examination. (select one category)
   - agree
   - partially agree
   - partially disagree
   - disagree

9c. …can serve as a template for learning objectives in class. (select one category)
   - agree
   - partially agree
   - partially disagree
   - disagree

9d. …can serve as a template for the publication of learning objectives (web site, module handbooks, etc.). (select one category)
   - agree
   - partially agree
   - partially disagree
   - disagree

10. What other benefits do you see? (free text)

Hypothetical benefits of a competency-based subject catalogue for students

11. For students, the added value of a competency-based subject catalogue over the current keyword-based subject catalogue is that it...

11a. …illustrates the relevance of examination content. (select one category)
   - agree
   - partially agree
   - partially disagree
   - disagree

11b. …informs about expected depth on what students are expected to know and how knowledge can be applied. (select one category)
- agree
- partially agree
- partially disagree
- disagree

11c. … creates links with later study content and applications that build on the first state examination. (select one category)
- agree
- partially agree
- partially disagree
- disagree

11d. …increases the motivation to learn by showing applications. (select one category)
- agree
- partially agree
- partially disagree
- disagree

12. What other benefits do you see? (free text)

Design of the subject catalogue

13. In terms of design, it is particularly important to me that the catalogue…

13a. …has a clear hierarchical structure/is hierarchically organised. (select one category)
- agree
- partially agree
- partially disagree
- disagree

13b. …is concise (no details, “less is more”). (select one category)
- agree
- partially agree
- partially disagree
- disagree

13c. …contains detailed and precise learning objectives. (select one category)
- agree
- partially agree
- partially disagree
- disagree

13d. …comprises additional information for the specification of learning objectives (competency levels, application examples, etc.). (select one category)
- agree
- partially agree
- partially disagree
- disagree

14. What else is important to you about design? (free text)

15. Here are four examples of the design of the subject catalogue. Please rank these four examples in order of preference (top: I like it best - bottom: I like it least). (Ranking)
- Example 1: focus on operationalised learning objectives
- Example 2: with additional sub-headings as in the keyword-based catalogue
- Example 3: same as 2, with competence levels highlighted in colour
- Example 4: same as 2, but with application examples

Beispiel 1: operationalisierte Lernziele im Vordergrund

1.1	**Allgemeine Chemie**
1.1.1	Sie können chemische Grundbegriffe und Definitionen im Dialog mit Fachleuten nutzen und sind fähig, Fachliteratur zu lesen. Hierfür erinnern sie Grundlagen über:
1.1.1.1 Stoff, Stoffumwandlung (chem. Reaktion), Element, Verbindung	
1.1.1.2 Atom- und Molekülhypothese nach Dalton bzw. Avogadro; Gesetze der Massenerhaltung, der konstanten und multiplen Proportionen	
1.1.1.3 Definition und Beziehungen von Masse, Volumen, Stoffmenge, relative Atom-/Molekülmasse, Gehalts- und Konzentrationsgrößen inkl. Einheiten und Symbole	
1.1.1.4 Bedeutung chem. Elementsymbole, Formeln und Gleichungen, stöchiometrische Berechnungen	
1.1.2	Sie können den Aufbau von Atomen beschreiben und können aus der Stellung eines Elements im Periodensystem Informationen über seine Eigenschaften und die seiner Verbindungen ableiten. Hierfür nutzen sie Kenntnisse über bzw. Kenntnis der:
1.1.2.1 Atombau	Protonen, Neutronen, Elektronen; Atommodelle; Quantenzahlen und Orbitale (räumliche und energetische Aspekte)
1.1.2.2 Elektronenbesetzung von Orbitalen	Pauli-Prinzip und Hund'sche Regel; Grundzustand und angeregte Zustände; Singulett- und Triplettzustände; Absorption und Emission von Strahlung
1.1.2.3 Radionuklide	Isotope, radioaktiver Zerfall und Strahlungsarten; Bedeutung für Radiotherapie, Radiodiagnostik und (Bio)analytik
1.1.2.4 Periodensystem	Aufbau des Periodensystems über die Elektronenbesetzung von Orbitalen; Elektronenkonfiguration, Valenzelektronen, Edelgaskonfiguration
1.1.2.5 Namen und Symbole der wichtigsten Elemente	
1.1.2.6 Anordnung in Perioden und Gruppen sowie deren Bezeichnung	
1.1.2.7 Periodische Eigenschaften	Atomradien, Ionenradien, Hydratationsradien, „Schrägbeziehung", Elektronegativität (EN), Ionisierungsenergie, Elektronenaffinität, Oxidationszahlen, Standardpotentiale; Metalle, Halbmetalle, Nichtmetalle

Beispiel 2: mit Teilüberschriften wie im Stichpunktkatalog

1.1	**Allgemeine Chemie**	
1.1.1	**Grundbegriffe und -gesetze**	Sie können chemische Grundbegriffe und Definitionen im Dialog mit Fachleuten nutzen und sind fähig, Fachliteratur zu lesen. Hierfür erinnern sie Grundlagen über:
1.1.1.1 Stoff, Stoffumwandlung (chem. Reaktion), Element, Verbindung		
1.1.1.2 Atom- und Molekülhypothese nach Dalton bzw. Avogadro; Gesetze der Massenerhaltung, der konstanten und multiplen Proportionen		
1.1.1.3 Definition und Beziehungen von Masse, Volumen, Stoffmenge, relative Atom-/Molekülmasse, Gehalts- und Konzentrationsgrößen inkl. Einheiten und Symbole		
1.1.1.4 Bedeutung chem. Elementsymbole, Formeln und Gleichungen, stöchiometrische Berechnungen		
1.1.2	**Atombau und Periodensystem der Elemente**	Sie können den Aufbau von Atomen beschreiben und können aus der Stellung eines Elements im Periodensystem Informationen über seine Eigenschaften und die seiner Verbindungen ableiten. Hierfür nutzen sie Kenntnisse über bzw. Kenntnis der:
1.1.2.1 Atombau		Protonen, Neutronen, Elektronen; Atommodelle; Quantenzahlen und Orbitale (räumliche und energetische Aspekte)
1.1.2.2 Elektronenbesetzung von Orbitalen		Pauli-Prinzip und Hund'sche Regel; Grundzustand und angeregte Zustände; Singulett- und Triplettzustände; Absorption und Emission von Strahlung
1.1.2.3 Radionuklide		Isotope, radioaktiver Zerfall und Strahlungsarten; Bedeutung für Radiotherapie, Radiodiagnostik und (Bio)analytik
1.1.2.4 Periodensystem		Aufbau des Periodensystems über die Elektronenbesetzung von Orbitalen; Elektronenkonfiguration, Valenzelektronen, Edelgaskonfiguration
1.1.2.5 Namen und Symbole der wichtigsten Elemente		
1.1.2.6 Anordnung in Perioden und Gruppen sowie deren Bezeichnung		
1.1.2.7 Periodische Eigenschaften		Atomradien, Ionenradien, Hydratationsradien, „Schrägbeziehung", Elektronegativität (EN), Ionisierungsenergie, Elektronenaffinität, Oxidationszahlen, Standardpotentiale; Metalle, Halbmetalle, Nichtmetalle

Beispiel 3: wie 2, mit graphisch hervorgehobener Kompetenztiefe

			Kompetenz tiefe
1.1	**Allgemeine Chemie**		
1.1.1	**Grundbegriffe und -gesetze**	Sie können chemische Grundbegriffe und Definitionen im Dialog mit Fachleuten nutzen und sind fähig, Fachliteratur zu lesen. Hierfür erinnern sie Grundlagen über:	1
	1.1.1.1 Stoff, Stoffumwandlung (chem. Reaktion), Element, Verbindung		
	1.1.1.2 Atom- und Molekülhypothese nach Dalton bzw. Avogadro; Gesetze der Massenerhaltung, der konstanten und multiplen Proportionen		
	1.1.1.3 Definition und Beziehungen von Masse, Volumen, Stoffmenge, relative Atom-/Molekülmasse, Gehalts- und Konzentrationsgrößen inkl. Einheiten und Symbole		
	1.1.1.4 Bedeutung chem. Elementsymbole, Formeln und Gleichungen, stöchiometrische Berechnungen		
1.1.2	**Atombau und Periodensystem der Elemente**	Sie können den Aufbau von Atomen beschreiben und können aus der Stellung eines Elements im Periodensystem Informationen über seine Eigenschaften und die seiner Verbindungen ableiten. Hierfür nutzen sie Kenntnisse über bzw. Kenntnis der:	2
	1.1.2.1 Atombau	Protonen, Neutronen, Elektronen; Atommodelle; Quantenzahlen und Orbitale (räumliche und energetische Aspekte)	
	1.1.2.2 Elektronenbesetzung von Orbitalen	Pauli-Prinzip und Hund'sche Regel; Grundzustand und angeregte Zustände; Singulett- und Triplettzustände; Absorption und Emission von Strahlung	
	1.1.2.3 Radionuklide	Isotope, radioaktiver Zerfall und Strahlungsarten; Bedeutung für Radiotherapie, Radiodiagnostik und (Bio)analytik	
	1.1.2.4 Periodensystem	Aufbau des Periodensystems über die Elektronenbesetzung von Orbitalen; Elektronenkonfiguration, Valenzelektronen, Edelgaskonfiguration	
	1.1.2.5 Namen und Symbole der wichtigsten Elemente		
	1.1.2.6 Anordnung in Perioden und Gruppen sowie deren Bezeichnung		
	1.1.2.7 Periodische Eigenschaften	Atomradien, Ionenradien, Hydratationsradien, „Schrägbeziehung", Elektronegativität (EN), Ionisierungsenergie, Elektronenaffinität, Oxidationszahlen, Standardpotentiale; Metalle, Halbmetalle, Nichtmetalle	

Beispiel 4: wie 2, mit Anwendungsbeispielen

1.1	**Allgemeine Chemie**		
1.1.1	**Grundbegriffe und -gesetze**	Sie können chemische Grundbegriffe und Definitionen im Dialog mit Fachleuten nutzen und sind fähig, Fachliteratur zu lesen. Hierfür erinnern sie Grundlagen über:	**Anwendungsbeispiele:** Grundlagen Teilchenmodell, Reaktionsgleichungen, chem. Rechnen; Fachliteratur verstehen
	1.1.1.1 Stoff, Stoffumwandlung (chem. Reaktion), Element, Verbindung		
	1.1.1.2 Atom- und Molekülhypothese nach Dalton bzw. Avogadro; Gesetze der Massenerhaltung, der konstanten und multiplen Proportionen		
	1.1.1.3 Definition und Beziehungen von Masse, Volumen, Stoffmenge, relative Atom-/Molekülmasse, Gehalts- und Konzentrationsgrößen inkl. Einheiten und Symbole		
	1.1.1.4 Bedeutung chem. Elementsymbole, Formeln und Gleichungen, stöchiometrische Berechnungen		
1.1.2	**Atombau und Periodensystem der Elemente**	Sie können den Aufbau von Atomen beschreiben und können aus der Stellung eines Elements im Periodensystem Informationen über seine Eigenschaften und die seiner Verbindungen ableiten. Hierfür nutzen sie Kenntnisse über bzw. Kenntnis der:	**Anwendungsbeispiele:** Spektroskopische Verfahren (insbes. UV-Vis-Spektroskopie, Flourimetrie etc.); Radiochemie und -therapie; Reaktivität und Stabilität von Stoffen; Analytik anorganischer Stoffe
	1.1.2.1 Atombau	Protonen, Neutronen, Elektronen; Atommodelle; Quantenzahlen und Orbitale (räumliche und energetische Aspekte)	
	1.1.2.2 Elektronenbesetzung von Orbitalen	Pauli-Prinzip und Hund'sche Regel; Grundzustand und angeregte Zustände; Singulett- und Triplettzustände; Absorption und Emission von Strahlung	
	1.1.2.3 Radionuklide	Isotope, radioaktiver Zerfall und Strahlungsarten; Bedeutung für Radiotherapie, Radiodiagnostik und (Bio)analytik	
	1.1.2.4 Periodensystem	Aufbau des Periodensystems über die Elektronenbesetzung von Orbitalen; Elektronenkonfiguration, Valenzelektronen, Edelgaskonfiguration	
	1.1.2.5 Namen und Symbole der wichtigsten Elemente		
	1.1.2.6 Anordnung in Perioden und Gruppen sowie deren Bezeichnung		
	1.1.2.7 Periodische Eigenschaften	Atomradien, Ionenradien, Hydratationsradien, „Schrägbeziehung", Elektronegativität (EN), Ionisierungsenergie, Elektronenaffinität, Oxidationszahlen, Standardpotentiale; Metalle, Halbmetalle, Nichtmetalle	

Online version of the catalogue

16. With the online version of the subject catalogue, it is particularly important to me that it…

16a. …allows one-click navigation through the hierarchy levels. (select one category)
- agree
- partially agree
- partially disagree
- disagree

16b. …provides the possibility to choose between different representations (e. g. as in examples 1 to 4). (select one category)
- agree
- partially agree
- partially disagree
- disagree

16c. …connects related learning objectives via links. (select one category)
- agree
- partially agree
- partially disagree
- disagree

16d. …provides a printable version (PDF) in the style of previous bound editions of the SC alongside the digital version. (select one category)
- agree
- partially agree
- partially disagree
- disagree

Criticism and suggestions

17. Do you see any disadvantages for you as a teacher or for the students in a competency-based design of the subject catalogue?
- yes
- no

17a. If you selected “yes”, please specify (free text)

18. What other aspects, not mentioned in this survey, would you consider important for the added value of a competency-based subject catalogue? (free text)

19. What other aspects, not mentioned in this survey, would you consider important for the design of the subject catalogue? (free text)

20. Would you be willing to participate in the ongoing development of the subject catalogue through an interactive online portal?
- yes
- no

Thank you for completing the questionnaire.

Appendix B: Four suggestions for outline and implementation.

Example	Outline/Implementation	Rank
1	Thematically organised chapter headings are replaced by formulations of competences and sub-competences: 1.1. General Chemistry is replaced by 1.1.1 Basic concepts and laws 1.1 "Graduates consider the general principles of chemistry. They can ..." 1.1.1 "… use basic chemical terms and definitions in discussions with experts and are able to read specialised literature."	4 (*S* = 369)
2	Thematically structured chapter headings and formulations of competences and sub-competences are presented side by side: 1.1. General Chemistry — 1.1 "Graduates consider the general principles of chemistry. They can ..." 1.1.1 Basic concepts and laws — 1.1.1 "… use basic chemical terms and definitions in discussions with experts and are able to read specialised literature."	2 (*S* = 409)
3	As example 2, with coloured bars to indicate the competence level (1 or 2) addressed by the listed learning objectives/test objectives.	3 (*S* = 377)
4	As example 2; in addition, an extra column next to the subjects and competences shows application examples or examples of related content from the third and fourth year of the Pharmacy degree programme (this is the version of the draft of the entire SC provided as a download in the survey).	1 (*S* = 425)