



Creation of a subject-specific task pool based on two examples of the academic success projects OSA 3.0

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Abstract

Die Gruppe der Studieninteressierten ist bzgl. Wissenstand und Interessenslage sehr heterogen, so dass es eine Herausforderung darstellt, z. B. den Vorlesungsstoff entsprechend des Vorwissens aufzubereiten, Praktika spannend zu gestalten oder eine adäquate Prüfungsvorbereitung anzubieten. Ebenso sind Ideen gefragt, um das eigene Wahlmodul vorzustellen oder für die Vertiefung an sich zu werben. Eine Lösung stellt ein fachspezifischer Aufgabenpool dar. Wie die Wissensstände in Erfahrung gebracht und Interesse geweckt werden kann, wird anhand des Studienerfolgsprojektes OSA 3.0 erläutert, wobei OSA für Online-Self-Assessment steht. Die einzelnen Prozessschritte werden im Detail beschrieben und die Entwicklung von zwei Aufgaben wird exemplarisch für diese Schritte gezeigt.

The group of prospective students is very heterogeneous in terms of knowledge and interests, so it is challenging to prepare the lecture material according to prior knowledge, to make practicals exciting or to offer adequate exam preparation. Ideas are also needed to present one's own elective module or to promote the specialization itself. One solution could be a subject-specific assignment pool. The academic success project OSA 3.0, short for online-self-assessment, will be used to explain how knowledge levels can be ascertained and how interest can be aroused. The individual steps of the process are described in detail and the development of two tasks is shown as examples of these steps.

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1. OSA 3.0 - What's the point?

The abbreviation OSA stands for Online Self-Assessment and has entered 2020 its third stage with Mechanical Engineering after Mechatronics and Electrical Engineering. The OSAs at the TUD are an academic success project aimed at people interested in studying STEM subjects (SI). Subject-specific tasks with a total working time of 90 minutes are offered, which in this case are intended to represent the mechanical engineering course of study. On the one hand, an impression of the challenges in the course of study is to be conveyed, whereby the focus is on the requirements in the basic modules. On the other hand, the specialisations and the possible work perspectives are presented. On the basis of this, the SI can test whether the course of studies would be suitable for them and what they can expect during their studies and beyond. The SIs can then better judge, what is expected of them and what is involved in the very broad field of mechanical engineering. This helps to dispel misconceptions about studying in general and for mechanical engineering in particular, with the aim of reducing the number of students quitting.

This offer is particularly important, if potential first-year students are unable to gain an in-

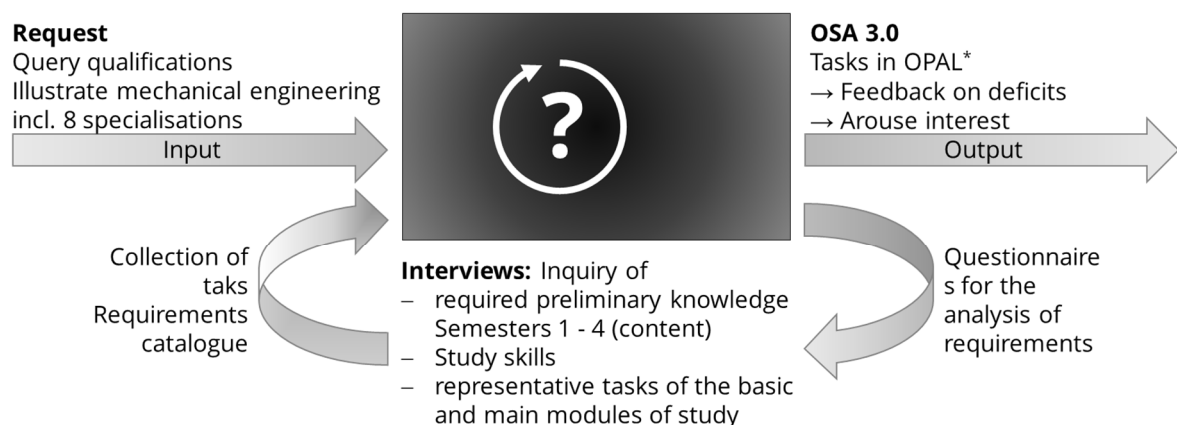
sight beforehand, be it due to logistical, financial or time barriers or organisational problems such as the cancellation of events, e.g. the Open Day or the Long Night of the Sciences (LNdW). Likewise, in times of digitalisation, spatial distances can be bridged and a time-independent offer can be made, which, apart from internet access, does not require any financial preconditions on the part of the SI.

How such specialised tasks were developed will be explained step by step in the following and thus a guideline will be given. Steps 2 to 5 are explained with the help of two concrete examples.

2. The initial Situation

First of all, the task can be clarified quite well with a black box, as shown in Fig. 1. On the one hand, the general requirements and expectations, as mentioned in the introduction, flow in as input variables. The necessary requirements or those to be integrated into the tasks are additional input variables, which, however, must first be collected in the process. The definition of the goal, in this case an OSA for the mechanical engineering course of study, serves as a starting point.

The creation of the tasks themselves is an iterative process.



* Online Platform for Academic Teaching and Learning

Fig. 1: Requirements and objectives of the OSA project as a black box

3. Step 1 - Analysis of requirements

In the first step, it had to be determined, which concrete contents should be included in the tasks. The analysis of requirements was chosen as the methodology, as it is flexible in its

creation and could thus be adapted exactly to the content to be requested.

Lecturers from the basic modules were interviewed in order to determine the required prior knowledge for the relevant modules of

the first four semesters, and on the other hand, to inquire about beginner's tasks. Furthermore, lecturers in the specialization modules were also interviewed in order to obtain examples or ideas for subject-specific tasks that should reflect the specialization modules. Further, all lecturers were asked to provide information on study competences, as skills and abilities are also tested by the category of question.

All respondents were given a standard questionnaire with open questions and they could decide which ones they wanted to answer and to what extent. These answers were preferably recorded in interviews, although it was also possible for the respondent to fill them in directly. The questionnaires and explanations were given to the interviewees a week in advance so that they could prepare for the appointment.

Questions and follow-up questions during the interview were designed in such a way, that the respondents were not influenced.

After the interviews were completed, all answers were summarized in a structured way in temporary requirement catalogues. Afterwards, in order to create a checklist of the most important requirements the respondents were given these catalogues for weighting. Only items that were identified as necessary were included in the technical tasks, as only a limited time of 90 minutes was set aside for handling them.

4. Step 2 - The general concept

In order to make the situation more realistic for the SIs and thus maintain the desire to solve the tasks, an overarching story was created. For the OSA 3.0, an internship in an SME¹ was constructed as a scenario in which insights into different areas of work are provided. The

collected ideas, suggestions and examples for the specialist tasks were grouped together with the own ideas, that arose through the interviews, with the focus on overlaps and topics. In the end, four departments emerged to which the tasks were assigned: conception, dimensioning, production and logistics.

Under conception, tasks are found that are aimed at research skills, gaining an overview and collecting ideas.

Dimensioning focus on the calculation and detailing of the ideas gained in conception. This area also includes design, simulation and programming.

Production includes tasks of shop floor management and manufacturing.

The last area, logistics, includes tasks related to the flow of goods, work routes and transport.

Example 1:

With regard to the insight into the study of mechanical engineering, suggestions were made from the fields of design with regard to technical drawings. This was assigned to "dimensioning".

Example 2:

From different modules, e.g. physics, technical mechanics, as well as logistics and automotive engineering, motion sequences and the calculation of distance, time and speed were suggested as key aspects. The resulting task was noted under "logistics".

An attractive design of the OPAL page goes hand in hand with the activation of the SI. The page layout should encourage the user to try it out. For this purpose an illustration was made for each department, which can be seen in Fig. 2.

¹ Small and medium-sized enterprises



Fig. 2: Visualization of the 4 departments for the appealing display on OPAL

5. Step 3 - Assignments of the requirements

After the general concept was established, the requirements of the weighted catalogue of requirements were assigned to the tasks. On one hand, the required preliminary knowledge (K) gave the tasks their content, on the other hand, the study competences (C) flowed into the structure of the tasks and into the questioning of results. Subsequently, the tasks were divided according to their importance into obligatory, elective and additional tasks.

Obligatory tasks (OT) require basic skills and knowledge. These must be solved by the SIs, when completing the OSA.

In the elective tasks (ET), the SIs can decide which ones they want to work on according to their interests, and thus get a taste of the specialization modules.

The additional tasks (AT) are usually evaluated subjectively, since for example creativity is required. These tasks are also time-consuming and serve as in-depth training.

Ex. 1: Component views (OT)

K: Sketches as an important tool of communication for an engineer (to present information in a clear way).

C: Three-dimensional imagination, visual intelligence

Ex. 2: Sprinter loading (OT)

K: Motion equations, integration

C: Logical thinking (recognizing connections and processes), ability to abstract (simplification of movement processes)

6. Step 4 - The implementation in OPAL

Before the tasks could be designed, objective evaluation criteria had to be defined and the associated implementation on the chosen platform had to be checked. In this example, the tasks were implemented in OPAL, which allows various types of questions such as cloze texts, diagrams and numerical value queries, but is also subject to restrictions. In order not

to lose the interest of the respondents, attention was paid to making various solution of the questions.

Ex. 1: Component views

The implementation of this question takes the form of a table, as shown in Fig. 3. In this table, the name of the object and the different views are to be entered, whereby only one view or the name is given for each component. The missing elements can be added by means of a drop-down menu or by dragging them from a stock to the desired place.


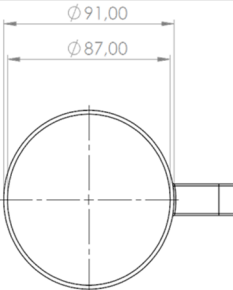
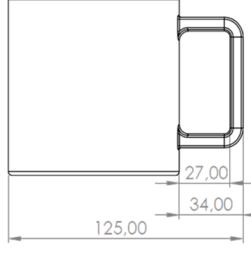
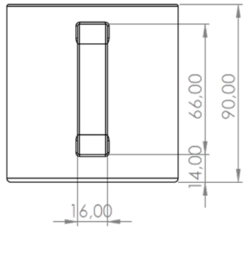
Name	3D view	Top view	Front view	Side view
Cup				

Fig. 3: Implementation of example 1 “Component views”

7. Step 5 - The concretization

When designing the tasks, the expected level of knowledge (in this case secondary level 2) should be taken into account. During the preparation of the mathematical path, it is useful to note down hints, stumbling stones and advance knowledge. For example, a concrete formula may not yet be known to the SIs, which is why it is given, but the transformation of the equation should be within the range of skills. Usually there is an introductory text that puts the task into context and contains the information needed to solve it. This text is then followed by the concrete task, as in the following examples.

Ex. 1: Component views

Introductory text:

As part of a small project, various items need to be created as 3D objects for review and submitted as technical drawings for production.

Ex. 2: Sprinter loading

In this task, different types of questions are combined. On one hand, results are requested by directly entering numerical values. On the other hand, a diagram can be generated by clicking on grid points. In addition, integrals are to be set up and solved. These equations can be entered directly and can be compared with a stored answer if the variables are specified.

Task:

Create an overview of the components under different views by completing the following table with regard to product description, 3D view, top view, front view and side view.

Ex. 2: Sprinter loading

Introduction text:

After determining how many boxes will fit into the sprinter, the loading time must be calculated. The boxes are loaded from the warehouse into the sprinter using a forklift truck. The forklift truck must drive several times, so in addition to loading and unloading, the empty runs must also be taken into account.

Task:

The forklift truck manages 3 cartons per trip, with loading and unloading taking 10 s each. The distance from the warehouse to the Sprinter is 120 m. The forklift has a maximum speed of 20 km/h, which is not affected by the

mass of the packages, and accelerates to 10 km/h in 8 seconds. The acceleration can be considered constant.

1. What time is needed for the 600 m with the forklift truck without loading and unloading time?
2. Draw the v-t and s-t charts for one trip by clicking on the points in the grid.
3. What are the integrals and the integrated equations for the velocity v and the distance s , if the following applies $a(t) = m t$ with $m = 0,5 \frac{m}{s^3}$ and $a = \dot{v} = \ddot{s}$?
4. How long does it take for the entire loading process, i.e. until the last box is loaded into the Sprinter?

The hints for the tasks are given on basis of the expected level of knowledge depending on the number of attempts to solve the problem. The students have 2 attempts at their disposal. In the first attempt (level 1), there are already hints that can be folded out and are available to the SI as needed with regard to their existing knowledge from school. In level 2, after the first failed attempt, concrete hints are given, e.g. in the form of intermediate results. After the second failed attempt, the solution is presented in level 3, including the solution path.

Ex. 1: Component views

Level 1: general information

As a supplement to the introductory text and the example of a cup given therein (see Fig. 3), another illustration (Fig. 4) is shown in order to give a better impression of the views or their allocation.

Level 2: Hints after failed attempt

The following text appears:

"The products are: ...

in this order.

There are also views that are not assigned to any component or represent a view that is not required."

Level 3: Solution

The following text appears:

"The complete overview is provided here as a PDF:" *Link to download the PDF*

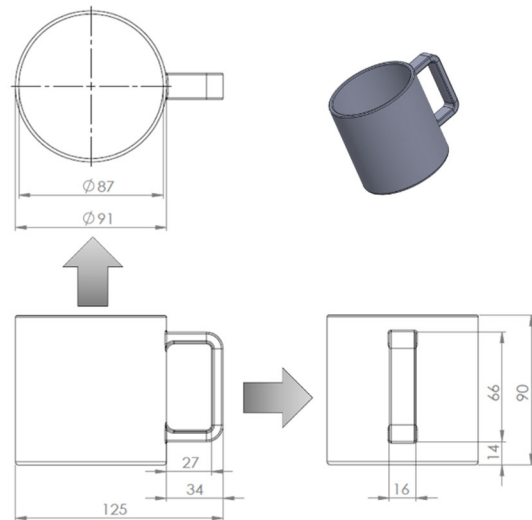


Fig. 4: Hint field of the 1st stage for the example 1 "Component views".

Ex. 2: Sprinter loading

Level 1: general information

The following text appears:

"Check your conversion of units.

The dots above a variable indicate the level of the derivative with respect to time."

Level 2: Assistance after failed attempt

The help depends on the subtask.

to 1. The sequence of movements is: Acceleration from rest to 20 km/h (uniformly accelerated movement) - constant speed (uniform movement) - braking to a standstill (uniformly decelerated movement).

to 2. Check that you have not made a misclick. Have you added up the values for the individual sections?

to 3. See Fig. 5

to 4. How often does the driver have to drive there and how often back? This is only about the loading time.

Level 3: Solution

At this point, formulas, results and the diagrams are shown.

When formulating the tasks, attention should be paid to using gender-appropriate language in order to address all SI. For the tasks, an inclusive choice of words was taken into account, as this builds bridges. The OSAs are a flagship

of the TU Dresden and reflect a (world-)open and tolerant policy.

If necessary, alternative versions should be written in different languages or in simple language.

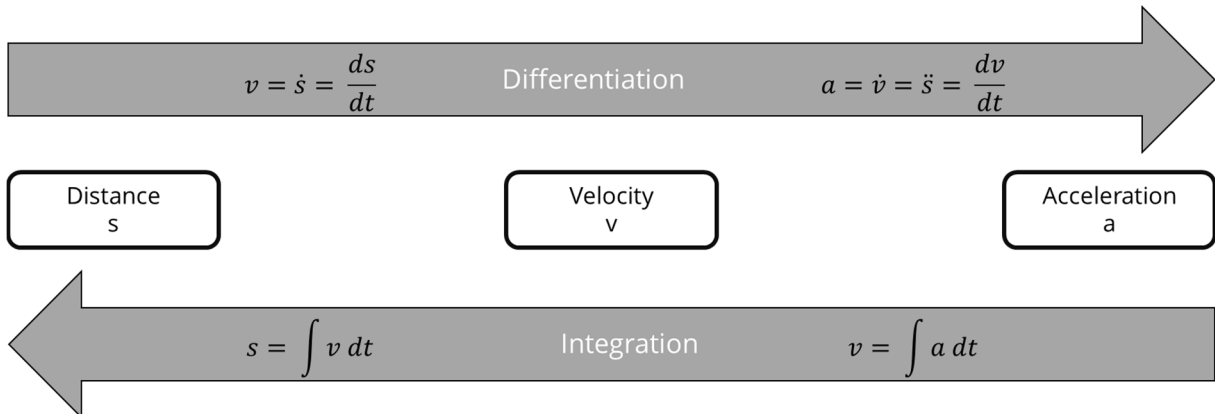


Fig. 5: Level 2 hints for task 3 of example 2 "Sprinter loading"

8. Step 6 - The evaluation

The tasks are adjusted several times. First, a comparison is made with the catalogue of requirements to see whether all relevant points have really been processed. Secondly, test runs are carried out first internally, then externally by the target group (in this case secondary school students). After each run, feedback is gathered and appropriate adjustments are made. Through this iterative process, stumbling stones and technical hurdles are to be removed so that a representative, user-friendly range of tasks is created in OPAL.

9. Possible applications

Now the procedure of developing tasks tailored to the requirements can also be transferred to one's own exercises, practicals or other (pre-) examinations, as Fig. 6 shows. Be it to arouse interest, to offer variety or to deepen knowledge. It can also be used as a guideline for developing new tasks to complement digital teaching.

Subject tasks in the form of an introductory test can also be used at the beginning of a semester in general or at the beginning of studies in particular. This can give an impression of the module and at the same time test (prior) knowledge in order to identify gaps.

This is helpful both for the students to work on deficits and for the lecturers, who can adapt their lectures on the basis of the results and in-

corporate repetitions if necessary. In particular, the knowledge gaps caused by the Covid 19 pandemic can be identified in this way and adapted measures can be taken.

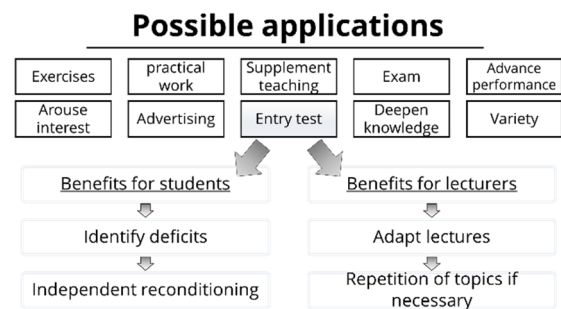


Fig. 6: Possible applications in everyday teaching.

10. Summary

Finally, the single steps should be summarized in Fig. 7, so that it can be used as a checklist for the creation of one's own subject-specific task pool.

Acknowledgement

Thanks to the colleagues from the OSA 3.0 project for the great cooperation.

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Thanks also go to Simon Schmitt for designing the images for OPAL.

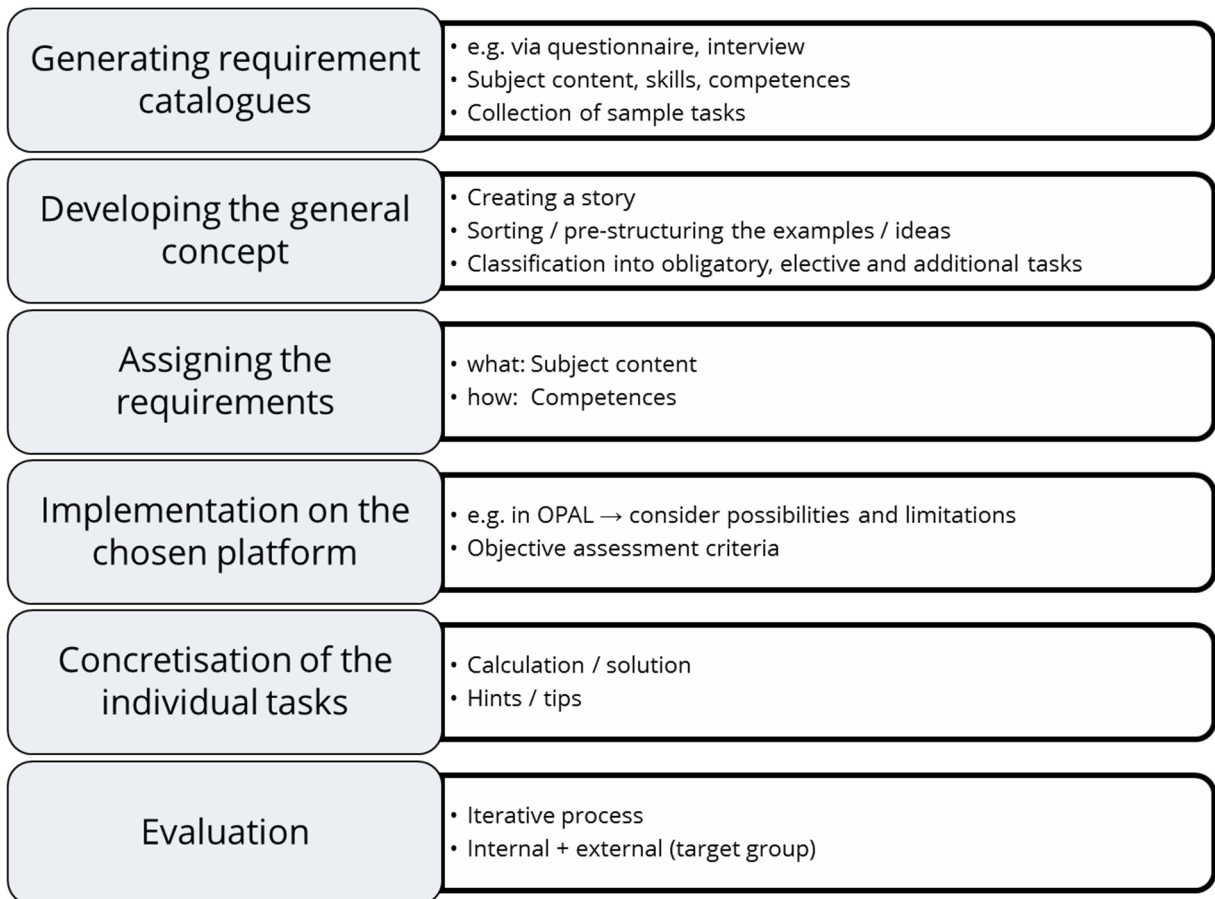


Fig. 7: Summary of the single steps for creating a subject-specific task pool.

Further information

<https://tud.link/w0un>

or try it out directly on OPAL:

Electrical engineering

<https://tud.link/nyyl>

Mechatronics

<https://tud.link/sqk0>

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