Research article

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Scaffolding for chemistry students – which tools are assessed as being more helpful: stepped supporting tools or task navigators?

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Abstract: In this paper the use of two different scaffolds in a seminar on the topic of heterocycles is discussed. The students first used both scaffolds (stepped supporting tools and a task navigator) on two tasks and could then choose for one other task the scaffold that suited them more. The scaffolds were evaluated in a mixed-methods study by the use of questionnaires and the conducting of a focus group interview. Both scaffolds were assessed as being helpful. However, students who thought they didn't need different sorts of tips, as provided by the task navigator, chose the stepped supporting tools. All students reflected on their use of the scaffolds; their choices for one of both are therefore well-founded. As the reasons for choosing the scaffold are very individual, in future seminars both types of scaffolds will be provided.

Keywords: organic chemistry; scaffolding; self-regulated learning; solving of tasks.

Introduction

Anderson and Bodner (2008) conclude that *"it is a mistake to assume that students know how to approach the learning of organic chemistry because they have been successful in general chemistry"*. Therefore, while teaching organic chemistry, not only the content, but also learning strategies should be taught (Crandell, Lockhar, & Cooper, 2010). One possibility for guiding and therefore supporting students while learning chemistry is the use of suitable scaffolds. Educational scaffolding was first mentioned by Wood, Bruner, and Ross (1976). They defined scaffolding as a teaching method that enables students to solve a problem, carry out a task, or achieve a goal through a gradual shedding of outside assistance. This assistance can be provided by a person, as described by Wood et al. (1976) or by materials as described by Taber (2002) and Hermanns and Schmidt (2019). In cognitive apprenticeship learning experts support the learners. The learners practice skills supported by coaching from the experts (Wilson, Teslow, & Taylor, 1993). According to Collins, Brown, and Newman (1989) cognitive apprenticeship consists of six major steps with scaffolding being one step; the experts help the learners until they can independently accomplish a task (also see Hay & Barab, 2001). Apprenticeship is *"a process where a beginner is gradually enculturated, with the goal of becoming an expert"*(Lave & Wenger, 1991). If the scaffold is a tutor, the tutor should reduce the degrees of freedom, direct maintenance and control the frustration of the learner. The students use scaffolds until they can apply new skills and strategies independently (Rosenshine & Meister, 1992); the scaffolding is therefore removed gradually when the students are able to solve their tasks independently (Larkin, 2002). Broman, Bernholt, and Parchmann (2018) support students while solving context-based chemistry problems. The scaffolding was provided by the interviewer; while the

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students solved their problems, the interviewer gave predefined hints with operators as for example name, describe or explain. For about half of the students the scaffolding was helpful; the answers by the students became increasingly complex. Although the scaffolds were rather simply designed, their use seemed to make an enormous difference with regard to the quality of students' answers. Caspari and Graulich (2019) also use scaffolding which is provided by the interviewer. Their scaffolding process consists of instructions as "identify which property changes of the reactant increase or decrease the energy of the reactant". A scaffolding grid as a reasoning scaffold was used by students while solving mechanistic contrasting cases (Graulich & Caspari, 2020). Livengood, Lewallen, Leatherman, and Maxwell (2012) describe scaffolding where professor and tutors supported the students by providing homework assistance. Scaffolding can also be provided by written materials. When written materials are used as scaffolds, the conceptual and information processing demands of each task should be carefully considered. Reiser (2004) describe as one possible scaffold the structuring of the task of problem solving. Taber (2002) uses different teaching materials as DARTs (Directed Activities Related to Text), PLANKs (Platforms for New Knowledge) and POLES (Provided Outlines LEnding Support). All scaffolds are provided by the teacher. The support is given whilst the learner is developing understanding and confidence in a topic. Examples for scaffolding by written materials are stepped supporting tools or task navigators. Stepped supporting tools (SSTs) are mainly known from chemistry lessons at school (Hänze, Schmidt-Weigand, & Stäudel, 2010; Leisen, 2003). As a basis for the development of SSTs for use at universities, Fach, de Boer, and Parchmann (2007) described an interview study. Hermanns (2020a) developed SSTs as scaffolds for non-major students while solving tasks in organic chemistry. Although the students rated the tools as helpful, a think-aloud-study showed that the tools are only helpful if the students have sufficient prior knowledge as well as methodical skills (Hermanns, 2020a). A new tool was therefore designed: the task navigator (Hermanns, 2020b). This scaffold provides strategical knowledge, the knowledge that has to be applied in the task and tips for the application of this knowledge. To support the students, the different sorts of tips are printed in different colors: the strategical tips in black, the knowledge tips in red and the application tips in blue. The concept for this scaffold is therefore named the STRAKNAP-concept (STRAtegy, KNowledge, APplication). In this paper, the development, use and evaluation of two sorts of scaffolds in one learning group are discussed; the students used both SSTs and task navigators while solving tasks in organic chemistry. For one task the students could choose their favorite scaffold. A mixed methods study was conducted to answer the question "which tools are assessed as being more helpful: stepped supporting tools or task navigators?"

Design of the study

The study was designed as a mixed methods study (see Table 1) and conducted in winter 2019–2020 in the course "Heterocycles" for chemistry students. The SSTs and the task navigators were rated by the students with the help of a questionnaire. In one seminar one task was solved while using the SSTs and another task while using the task navigator (named seminar 1). In another seminar (named seminar 2), the students could choose which scaffold they wanted to use while solving their task. For the evaluation of the use of both scaffolds for one task, the questionnaire used before (Hermanns & Schmidt, 2019) as well as two new questionnaires with closed and open items were used. To ensure that the students who chose a scaffold also used both tools in the prior seminar, the questionnaires were coded. To further investigate how the students chose their scaffold, a focus group interview was conducted. All elements of the study are described below.

The seminar and its students for the course "Heterocycles" for chemistry students

The course "Heterocycles" for chemistry students is a course in the third year for students studying chemistry. In this course 30 students were enrolled. However, not all students participated regularly in the lecture and the seminars, because the attendance is optional. The course consists of a lecture and a seminar where the contents of the lecture are applied and trained. At the end of the course there is a written exam. Because

Table 1: The mixed methods design of the study.

Content	Instrument	Method
Seminar 1: Task "four stepped synthesis" with stepped supporting tools and the task "Naratriptan" with a task navigator	Questionnaires with a four-item Likert scale	Quantitative
Seminar 2:	Questionnaires with a four-item Likert scale	Quantitative
Task "Imoxen" with both scaffolds: The students chose their favorite scaffold	Two new questionnaires with a four-item Likert scale regarding the choice of the students	Quantitative
	Open questions regarding the choice of the students	Qualitative
The choice of the scaffold by the students	Focus group interview with five students	Qualitative

teaching organic chemistry is always a challenge (Lafarge, Morge, & Méheut, 2014), for the seminar new methods are developed: for the preparation of the seminars, homework sheets for the students with tips for following up on the lecture were designed, and for the use in the seminars two sorts of scaffolds were developed and used. In the seminars all tasks were solved together; a special focus lies on the application of the knowledge from the lecture to ensure that the students can build up conceptual knowledge on the topic.

The questionnaire on the use of the stepped supporting tools and the task navigators

To investigate how the students rated the SSTs and the task navigator, the questionnaire developed for the evaluation of the SSTs was used (Hermanns & Schmidt, 2019). For the rating of the scaffolds chosen by the students for the task "Imoxen", this questionnaire was also used. For the evaluation of the tasks a four-item Likert scale was used (Likert, 1932). The students could select either "strongly disagree", "disagree", "agree" or "strongly agree", using the forced-choice method by removing the neutral option ("neither agree nor disagree") (Allen & Seaman, 2007). Table 2 shows this questionnaire.

The questionnaires regarding the choice of a suitable scaffold

In the seminar where the task "Imoxen" should be solved by the students (seminar 2), the students could choose their favorite scaffold: both SSTs and a task navigator were available. Before using the scaffold, the students should give the reasons for their choice and rate what they expect from the tool by using a small questionnaire with a four-item Likert scale (see Table 3).

After the use of the scaffold, the students should discuss whether they would decide in the same way and also rate the tool with the familiar questionnaire (Table 2) and with a new questionnaire on the quality of the tool (see Table 4).

Table 2: The questionnaire for rating the task navigators.

Statements for response: the task navigators…	Strongly disagree	Disagree	Agree	Strongly agree
Are arranged logically				
Are formulated clearly				
Explain the exercise				
Are scaled correctly				
Help classify the exercise				
Explain how to solve an exercise				
Are useful for preparing exams				

Table 3: Expectations of the students regarding their chosen scaffold.

From the scaffold I expect….	Strongly disagree	Disagree	Agree	Strongly agree
Solving steps				
Strategies for solving the task				
Provision of the required knowledge				

Table 4: The quality of the stepped supporting tools or the task navigator.

	Strongly disagree	Disagree	Agree	Strongly agree
The solving steps were sufficient				
The strategy for solving the task was clear				
The provided knowledge was sufficient for solving the task				

The focus group interview

To further investigate why the students chose their scaffold, a focus group interview (Krueger & Casey, 2014) was also carried out. The benefit of focus group interviews is the use of group interactions to produce data and insight that would be less accessible without such interaction (Morgan, 1988). One audio-taped focus group interview was conducted with five students (two female, three male). Two students chose in the seminar the SSTs and three students the task navigator as their favorite scaffold. The students were informed about the study and recruited in the lecture. They received 15 Euros as compensation for their time invested. The goal of the study and the use of the data were once again explained to the students at the beginning of the focus group interviews; ethical guidelines were followed. The approval of the institutional review board is not required at German universities. To ensure anonymity, the students were numbered by a code. They said their code before speaking so that the contributions could be assigned. The transcripts were evaluated according to Kuckartz (2016) using the method of qualitative content analysis. The excerpts used for this paper were translated from German to English.

The design of the scaffolds

For three tasks different scaffolds were designed: for the tasks “four stepped synthesis” and “Imexon” SSTs and for the tasks “Naratriptan” and “Imexon” a task navigator. The SSTs and the task navigators were designed by the author. For this design, an analysis of the task at hand was conducted. Guideline for this analysis was the dividing of the solving process in singular steps. Both SSTs and task navigators should consist of clear task descriptions to ensure that the students are able to understand what they should do. The greatest challenge while designing the scaffolds is to foresee what support the students really need. To continuously improve the scaffolds, an evaluation of their usage is therefore essential. SSTs and task navigators are designed by the author and used by the author and colleagues in several university courses repeatedly. Both tools have been evaluated by questionnaires and think-aloud studies. The results from this studies were used for the design of both scaffolds used in this study. For the design of one scaffold approximately 45–90 min is needed. For the design of the SSTs is less time needed because this tool is not as complex as the task navigator. A guideline for designing SSTs can be found in the literature (Hermanns & Schmidt, 2019).

To illustrate the differences between both scaffolds, both scaffolds for the task “Imexon” are shown in Table 5. Figure 1 shows the reaction schema for the synthesis of Imexon.

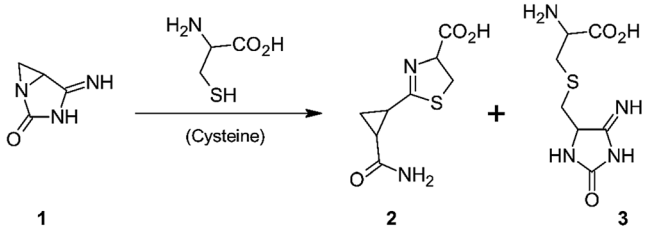
Table 5: The scaffolds for the task "Imexon".

Scaffold	The stepped supporting tools	The task navigator
1	Compare the reactant and the product with each other. Write down the differences. What conclusions can you draw about the reaction?	Write down the most important terms from the headline and the task.
2	In the first step, the SH-group of the cysteine attacks the partially positively charged C atom of the C=N double bond. This will open the five membered ring; write down this step.	Cysteine is an amino acid and contains a thiol group. Write down the structural formula of cysteine.
3	The free electron pair of the NH_2 group attacks the C atom of the double bond to the NH group; a small molecule is split off. Compound 2 is formed.	Compare the reactant and the product with each other. Write down the differences. What conclusions can you immediately draw about the reaction?
4	The SH group can also attack the aziridine; in this case a nucleophilic ring opening takes place, forming compound 3. Write down this step.	Define "annelatedd"
5	–	In the first step, the SH group of the cysteine attacks the partially positively charged C atom of the C=N double bond. This will open the five membered ring; write down this step.
6	–	The free electron pair of the NH_2 group attacks the C atom of the double bond to the NH group; a small molecule is split off. Compound **2** is formed.
7	–	The SH group can also attack the aziridine, where a nucleophilic ring opening takes place, forming compound **3**. Write down this step.

The task navigator starts with a strategical tip: "write down the most important terms of the headline and the task". The SST starts with "compare the reactant and the product with each other". This first tip of the SST is the third tip of the task navigator. The task navigator is more detailed and consists of a color code; strategical tips (in black) as well as required knowledge (in red) are given. The SSTs consist of four tips; the task navigator of seven tips all in all. The second step of the SSTs is the fifth step of the task navigator; it is the first application tip and therefore printed in blue. After each tip a solution is given. For clarity reasons the solutions are not part of Table 5 (see supporting information).

Results and discussion

In seminar 1 two tasks were solved by the students; for one task stepped supporting tools and for the other task a task navigator were available. The students had to use both scaffolds. Directly after the use of the scaffold, the students rated the scaffold with a questionnaire. Both scaffolds were assessed as being helpful; the arithmetic means for all items are between 2.86 ("agree") and 3.77 ("strongly agree"). As shown in Table 6, the students rated the stepped supporting tools for five out of seven items better than the task navigator. Only for the items "help classify the exercise" and "are useful for preparing exams" the rating of the task navigator was better (Cohens d = −0.550 resp. −0.353). This is not unexpected as the task navigator provides tips on the required



1 2 3

Figure 1: The synthesis of Imexon.

knowledge. The combination of required knowledge and its application both enables the students to classify the exercise or to use the task for exam preparation; the information content is much higher than in the SSTs. However, the better rating of the SSTs for five items may also be due to the fact that this scaffold was already known to the students, probably from their school days. One other explanation is the scope of the task navigator; there is more information and therefore the students have to read and process more text. This is supported by comparing the rating for the item "are formulated clearly"; the SSTs are rated much better than the task navigator (Cohens d = 0.706). It is possible that the quantity of text in the task navigator had an influence on the rating. Beyond that the task navigator gives a clearer sequence of the individual steps as the SSTs; the students are more limited in their own doing which can also be a reason for the less well rating. The task navigator also gives strategical tips as "write down the most important terms of the task". We observed in many seminars that students don't do this unless they are forced to. A scaffold that invites them to do something they normally don't do is therefore most likely not very popular with the students. The limitation of the own actions can also be a reason for the rating of the item "are scaled correctly" for the task navigator; with 2.86 the arithmetic mean is the less good in the rating of both scaffolds. The scaling of the tips in the task navigator seems to deviate from the scaling the students would choose voluntarily.

To further investigate what the students expect from a scaffold, in seminar 2 the questionnaire was expanded; the students rated before they solved the task their expectations for the scaffold they chose. A first comparison shows that the expectations of the students who chose the task navigator were higher (see Table 7). A possible explanation can be that the students who chose the task navigator made a more reasoned choice; they knew that they needed a scaffold and chose therefore the more detailed one. Students who thought they either didn't need a scaffold at all or maybe a scaffold that gave them the opportunity to think more independently would most certainly choose the SSTs. The choice of a scaffold was forced; the students had to take one of both. The rating of the item "provision of required knowledge" supports this explanation. The rating for the SSTs was with an arithmetic mean of 2.40 between "not agree" and "agree"; the students thought that their own knowledge was sufficient for solving the task. The students who chose the task navigator however rated this item with an arithmetic mean of 3.00; they agreed with the provision of required knowledge. It seems therefore likely that they made a positive choice for their scaffold whereas some students who chose the SSTs most certainly chose them because it seemed the lesser of two evils. It can therefore be concluded that the reasons for choosing the scaffold are very individual.

In addition to the questionnaire the students could give their reasons for choosing the scaffold. They should also name advantages and disadvantages for both scaffolds. The students who chose the task navigator named the color code as an advantage and gave as reasons for choosing the scaffold the more detailed tips of the task navigator and the thematic classification of the task. As disadvantage of the task navigator the students who chose the SSTs named too much text and information. However, they saw the color coding as an advantage and also providing the required knowledge (for students who needed this). They chose the SSTs because they wanted a scaffold which only gave specific tips for the task at hand; as advantage the SSTs were assessed as being more structured and clearer.

Table 6: The rating of the questionnaires for the SSTs and the task navigator in seminar 1.

Item	SST* for the task "four step synthesis" $N = 22$	Task navigator* for the task "Naratriptan" $N = 22$	Cohens d (SST to task navigator)
Are arranged logically	3.77 (0.685)	3.57 (0.598)	0.311
Are formulated clearly	3.50 (0.598)	2.91 (1.019)	0.706
Explain the exercise	3.59 (0.590)	3.14 (0.710)	0.689
Are scaled correctly	3.27 (0.703)	2.86 (0.774)	0.555
Help classify the exercise	3.00 (0.816)	3.41 (0.666)	−0.550
Explain how to solve an exercise	3.64 (0.581)	3.45 (0.6719)	0.303
Are useful for preparing exams	3.27 (0.767)	3.45 (0.596)	−0.353

*Arithmetic mean and (standard deviation).

Table 7: The rating of the students on their expectations of their chosen scaffold.

From the scaffold I expect	SST* for the task "Imexon" $N = 17$	Task navigator* for the task "Imexon" $N = 6$	Cohens d (SST to task navigator)
Solving steps	3.00 (0.632)	3.17 (0.753)	−0.245
Strategies for solving the task	3.55 (0.688)	3.83 (0.408)	−0.495
Provision of the required knowledge	2.40 (0.699)	3.00 (0.632)	−0.900

*Arithmetic mean and (standard deviation).

After solving the task with their scaffold of choice it was rated by the students using the same questionnaire as in seminar 1. Table 8 shows the results of this rating.

Overall the arithmetic means are higher (between 3.18 and 3.91) than in the ratings of the scaffolds in seminar 1. One reason can be that the students could choose their favorite scaffold and viewed it therefore more positively. However, it is also possible that the students rated "their" scaffold positively because it fitted their needs. As discussed for seminar 1, the task navigator was again rated better for the items "help classify the exercise" (Cohens d = −0.683) and "are useful for preparing exams". It seems that the task navigator is more suitable for those purposes. All students rated their chosen scaffold as formulated clearly; the arithmetic means were nearly identical (3.64 vs. 3.67). The students were obviously content with their choice. However, the item "explain the exercise" was rated significantly better for the SSTs (Cohens d = 1.056). Maybe the additional tips (for strategy and knowledge) in the task navigator muddied the sight on the task at hand somewhat. The rating of the scaffolds allow the conclusion that all students seemed content with their choice. To further investigate this point, the students rated the use of their chosen scaffold with another questionnaire. The results are shown in Table 9:

The students who chose the SSTs seem a little bit more content (arithmetic means for all items between 3.64 and 3.73 vs. between 3.33 and 3.50). However, all ratings are between "agree" and "strongly agree" and therefore at the head of the range. It seems that the students who chose the task navigator have a greater demand for help; the item "the provided knowledge was sufficient for solving the task" received with its arithmetic mean of 3.33 the lowest rating. This item is the most personal one because it depends on the individual knowledge; the demand on providing knowledge seems therefore to be of greater interest for the students who chose the task navigator.

To support the interpretation of the ratings the students were asked an open question: "Would they choose the same scaffold again?" All students answered the question with "yes". The students who chose the SSTs emphasized the stepwise approach and the providing of the solution after each SST. However, the students also gave some tips to improve the SSTs for the task "Imexon", as for example more steps for the reaction mechanism and the use of electron pushing arrows. One student mixed both scaffolds up as the citation explains: *"At this point I am not well enough prepared to solve the task without concrete indications. After carefully working through the material, the navigator would probably be better"*. Obviously the student thought that the navigator was the scaffold with less tips. However, this student was also content with the chosen

Table 8: The rating of the questionnaires for the SSTs and the task navigator in seminar 2.

Item	SST* for the task "Imexon" $N = 11$	Task navigator* for the task "Imexon" $N = 6$	Cohens d
Are arranged logically	3.91 (0.302)	3.67 (0.516)	0.568
Are formulated clearly	3.64 (0.674)	3.67 (0.516)	−0.050
Explain the exercise	3.82 (0.405)	3.33 (0.516)	1.056
Are scaled correctly	3.45 (0.522)	3.33 (0.516)	0.231
Help classify the exercise	3.18 (0.874)	3.67 (0.516)	−0.683
Explain how to solve an exercise	3.55 (0.522)	3.67 (0.516)	−0.231
Are useful for preparing exams	3.36 (0.924)	3.50 (0.548)	−0.184

*Arithmetic mean and (standard deviation).

Table 9: The rating of the students regarding the quality of the stepped supporting tools or the task navigator.

	SST* for the task "Imexon" $N = 17$	Task navigator* for the task "Imexon" $N = 6$	Cohens d
The solving steps were sufficient	3.64 (0.674)	3.50 (0.548)	0.228
The strategy for solving the task was apparent	3.73 (0.467)	3.50 (0.548)	0.452
The provided knowledge was sufficient for solving the task	3.70 (0.675)	3.33 (0.516)	0.616

*Arithmetic mean and (standard deviation).

scaffold. The students who chose the task navigator did so because the task navigator provided many tips that in their opinion were needed by the students (*"Since my knowledge level is still quite low, I would prefer this method"*). Also the color code was named positively: *"the color code illustrates visually the different tips"*. The evaluation of the answers to the open question supports the conclusion that the students' reasons for the choice of a scaffold are very individual. To investigate whether this conclusion can be validated, a focus group interview with five students was conducted.

At the beginning of the interview all students stated why they chose their favorite scaffold. Two students emphasized the color code as an important reason for choosing the task navigator (*"I think that the classification in colors is quite practical"*) and one student the providing of other tips (for example strategic tips). The reasons for choosing the SSTs (and not choosing the task navigator) were the color code of the task navigator (*"I don't know what to with that"*) and the formulation of questions in the SSTs. In Table 10 the most important statements of the focus group interview are summarized.

Table 10: Input interviewer and opinions of the students.

Input interviewer	Opinions of the students
Which tool requires more prior knowledge?	The SSTs. The navigator includes the required knowledge. The SSTs have also questions that are only answerable if you have the knowledge (students 3, 4).
The task navigator; a scaffold for using in the seminar or also for preparing written exams?	The task navigator is more suitable for preparing written exams than the SSTs, because the task navigator also includes the required knowledge (students 3, 4, 5). The SSTs because some of the questions are comparable to the questions in the written exams (student 2). Both scaffolds because both are systematical (student 1).
Is one scaffold more suitable for bachelor, master or non-major chemistry students?	Task navigator more suitable for beginners or non-major chemistry students (students 1, 2, 4); *"for beginners more suitable for showing what is important, which knowledge do I have to apply"* (student 2).
First tip of the task navigator: "Write down the most important terms of the task".	Personal opinions: The tip is unnecessary, because it's what you normally do (student 1, 2, 5) or it is not unnecessary; *"it helps not losing the red thread"* (student 4). Depends on the person; for some people it is necessary (students 1, 3, 4, 5).
Scaffold can be chosen by the students.	Good idea; both scaffolds for choosing by the students (students 3, 5); *"I would offer both, because everyone is a little bit different from his level of knowledge"* (student 5).
Frequency of the use of the scaffolds in seminars.	When the seminar has 2 h / week I would say to use the scaffold bi-weekly (student 2). Depends on the task (student 3, 2).
Scaffold as written material or projected through the beamer?	Written material; it allows working at your own pace (students 3, 4, 2, 1). Written material is also available for working at home (student 3).

The students have recognized the most important difference between the SSTs and the task navigator; students who use the SSTs need more prior knowledge than students who use a task navigator, because the task navigator provides the required knowledge. This is also the reason for their rating of the usability of the tools for exam preparation. Because the task navigator includes knowledge, it is rated to be more suitable for this purpose. In the opinion of the students the task navigator is therefore especially a tool for beginners; advanced students who have more knowledge should not need a task navigator as scaffold. Scaffolds should be used not too often; but the use also depends on the task. They are especially useful as written material, because students can then work at their own pace.

Summarizing, the results of the focus group interview show that the use of the scaffolds depends on the person who uses it and of the task at hand. The students therefore recommend providing both scaffolds; each student can then use the scaffold that suits him or her better.

Consequences and outlook

There are some limitations to this study and its results as there were only 30 students enrolled for the course "Heterocycles" in winter 2019/2020. From this group 22 students were present in seminar 1 and 17 students in seminar 2 (all 17 were also present in seminar 1). Due to this small number of participants, the study should be seen as exploratory. Nevertheless are the results of interest as they show that the students reflect on their use of scaffolds and if they can choose between two sorts of scaffolds their choices are well-founded. The results also show that the students rated both scaffolds for solving tasks as helpful. Both tools will therefore be used in the next course. Teachers in the field of chemistry should therefore be encouraged to design and use scaffolds for supporting their students. Especially using written materials as scaffolds, for example SSTs or task navigators as used in this study, is assessed as suitable because they allow the students to solve the task at their own pace. Therefore, for the use in our seminars new SSTs as well as task navigators will be designed. The students can then, after getting to know both tools, choose which tool suits them better. Although this is more time consuming for the teacher who designs the scaffolds, we think it is worthwhile. The first new scaffolds will be designed, used and evaluated in the course "Organic chemistry" for future chemistry teachers in the winter term 2020/2021. In the future the tasks and the scaffolds for several courses will be made available digitally. In a digital tool, technical terms can be explained by using links. The students can then choose individually if they need this explanation or not. Also can the students then use the tools when and wherever they want.

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