Example for Hybrid Learning - Analysis and Assembly of a Pneumatic Clamping Device

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1. Abstract

The lessons presented here were developed within the framework of the Erasmus project at Max-Born-Berufskolleg in Recklinghausen for a class of vocational school. The students have achieved a school leaving certificate at a low qualification level at a general education school in Germany. All of them have not succeeded in finding an apprenticeship in the dual system due to their low level of qualification. The vocational school aims to impart basic knowledge in the vocational field of metal technology to the students in one school year and to enable them to obtain a higher school leaving certificate at an intermediate qualification level.

All students show considerable deficits, especially in the fields of structured and self-organised learning, and language competence (due to migration background). With regard to the use of digital media, the students have no or only very limited knowledge. No one owns a digital device.

Thus, a central task was initially to introduce the learning group to the use of ipads provided by the school.

Only after this step it was possible to establish a hybrid form of teaching with corresponding individual support options to compensate for the above-mentioned competence deficits.

What are the advantages of a hybrid learning setting in this learning group? In the context of the teaching presented here, hybrid learning is understood as a format of blended learning that is oriented towards the Flipped Classroom variant. As will be described below, the learning deficits of the individual students are manifold. As a result, a far-reaching individualisation of teaching is necessary. This can only be realised to a very limited extent in a "classical" setting of lessons with a central control function of the teacher. This would also make it difficult to promote the necessary independence of the students in their own learning process. For this reason, a learning format was introduced in the class that provides for increasingly longer self-learning phases. Corresponding digital platforms for organising and individualising the learning processes serve as a structuring element for these work phases. As envisaged in the flipped classroom model, there are also regular exchange phases in the plenary for the preparation or evaluation of these work phases. The lessons thus take place - in phases asynchronously - in the classroom; distance formats are not envisaged.

What are the advantages of using digital media in this learning group? First of all, the students acquire basic software skills by using the software to create texts, photos and videos etc. The students are able to use the software in a variety of ways. As described above, one advantage is the individualisation of the learning processes. In the lessons described in detail below, the *Classroom Screen* and *Padlet* serve as a central platform for organising the students' collaborative work in small teams. In this case, teaching takes place at two levels. The corresponding differentiated documents are stored on the *Padlet so* that the work can be done at a pace determined by the students themselves. In addition, the use of digital media allows for a much greater variety in terms of the learning products. The creation of explanatory videos, photo material with information texts etc. leads to a significantly higher motivation. In addition, the creation of a short video, for example, is associated with a higher demand, but also promotion in the area of language competence. Another advantage is that the creation of this type of learning outcome requires constructive cooperation between the

students. This could not be achieved through the "classical" working on tasks on worksheets. In the reception of information, videos with subtitles (in addition to further information texts) also offer weaker students the possibility of a deeper understanding.

In the following detailed explanations, a lesson that follows this concept is described. This lesson is part of a longer learning situation in which the students design and realise a pneumatic control for a clamping device.

Learning Environment (Photo Dominik Preilowski)

2. Analysis of the students` current individual competences

A total of 14 male students aged 16 to 24 attend the BF2M class. All students fulfil the admission requirements by having a lower secondary school leaving certificate grade 10 or equivalent. The following table shows the actual individual skills and competencies and the qualification needs.

	Student-related learning requirements	Skills to be developed (long term)	Skills to be developed (described lesson)
Ability to perform and learn	The students can be divided into 2 learning groups, although 10 of the 24 students have significant language deficits: - 4 learners show an intermediate level of proficiency. They are able to understand given tasks and often advance the learning process. - Ten learners show a low level of proficiency. They need a lot of support from the teacher when working on tasks. The subject knowledge can only be retrieved to a limited extent according to the situation.	- Encouraging and supporting language competence and writing skills for all learners. - Promoting self-organisation among the lower-performing learners. - Encouraging independent deepening of subject knowledge	- Promoting the social competence of all learners by continuously creating opportunities for communication. - Promoting language competence and writing skills through differentiated tasks on 2 levels
Willingness to perform and learn	The performance and learning readiness of all learners shows a high volatility and a short concentration phase: -6 learners show a medium willingness to learn and perform. They manage tasks partly independently. - 8 learners show a low willingness to perform and learn. They are predominantly reserved in cooperative work processes and contributions in class.	- Promoting personal responsibility in terms of performance through cooperative forms of learning - Encouraging active participation in lessons	Promoting ownership and communication through clear responsibilities for each student
Current technical knowledge	The learners have no previous technical knowledge of pneumatics or the assembly of pneumatic controls from the previous school years.	Activation of the knowledge already acquired in the learning situation through continuous use of the digital work plan in the Padlet	Activation of already acquired knowledge through impulse questions and use of the digital work plan
Current methodological knowledge	Learners are already familiar with different social forms, methods and learning platforms. Working in learning situations, with digital plans and methods of reflection were new to them at the beginning of the school year.	Promotion of methodological skills through ritualised implementation of methods and media	Use of ipads, classroom screen, padlet and Microsoft Word to consolidate methodological skills and digital competences
Learning atmosphere in the class	The overall atmosphere in the class is pleasant. Nevertheless, minor disagreements are discussed loudly. Overall, the climate in the class is conducive to learning and there is a good working atmosphere. Some learners have problems keeping to an acceptable volume level.	Encouraging positive togetherness to achieve an appropriate volume level and a pleasant social climate	Promoting cooperative and communicative collaboration by working in teams

3. Didactic considerations for the learning situation

The learning situation is situated in the ficticious company Deckert GmbH and the learning process is initiated by an e-mail, which can be found in Annex B. In the e-mail, the trainee Paul Müller is given partial responsibility for the development and assembly of a pneumatic clamping device by the production manager Patrick Schulz. The development and assembly of a pneumatic clamping device was chosen as the topic of the sequence of lessons because the syllabus of curriculum prescribes the superordinate learning field 3 "Assembly and commissioning" for the subject Assembly and maintenance processes (QUA-LIS NRW Berufsbildung, 2015). The guidelines are focused on assembly and commissioning with the phases development, alternative technical solutions, assembly, control, operation and readjustment. In the learning situation, communication takes place between the production manager and the trainee about the development and assembly of a pneumatic clamping device. The constructivist didactic principle states, among others, that learners should expand their professional competence by being given authentic problems with a concrete application reference (Riedel, 2011). The expansion and development of professional competence takes place through the pneumatic clamping device, which exemplarily represents every technical system.

A digital work plan in the padlet serves as a visualised support tool, which is used in every lesson and adapted and supplemented during the lessons. The plan is presented in Annex C. The repeated presentation and discussion of the work structure is done in order to make better use of pedagogical potentials in the students' learning culture (Wulf, 2007). The use of ritualised learning cultures opens up playful spaces for self-creation and self-education (Wulf, 2007). The intensification of learning processes and the promotion of self-determined learning take place through images, schemata, figurations and work plans (Wulf, 2007). The digital work plan is marked by green arrows, which represent the project cycle as schemata.

Each project stage in the work plan, such as the assembly of the pneumatic clamping device, represents a standardised learning concept. The standardised learning concept repeatedly ritualises learning cultures and intensifies learning processes (Wulf, 2007). The learning concept of the lesson shown in Annex D and E is based on the model of complete professional work processes in order to promote the students' competence to carry out professional work processes competently (Rebmann et al., 2005). The didactic model of complete professional work processes includes the information, planning, decision-making, realisation, control and evaluation phases (Rebmann et al., 2005). Each column in the padlet represents a learning process that is aligned with one or more phases of this model. The columns of the padlet are shown in Annex D and E. For example, the column titled "Information Material" represents the information phase. The planning, decision-making and realisation phases are stimulated by the second column, "Task", in the learning process. In the third column, learners can upload their results, which serves as the basis for the presentations. The last column contains a feedback template to control and evaluate the learning process. The feedback template is shown in Annex F. The students` feedback is based on the feedback principle and is differentiated and adapted to the students` skills (Steinke, 2007).

The teaching presented here takes place at 2 different levels based on the diagnosis of the students` skills. The 2 groups receive different tasks and objectives each lesson, each of which

is based on the educational level of the group. The ★★ group represents learners who demonstrate an average level of learning and performance. The learners who are characterised by a low level of competencies and performance are members of the ★ group. A far-reaching individualisation of teaching is based on §1 of the School Act, which describes individual support as a right of every young person. According to §2 Para. 9 SchulG, learners with special needs should receive support tailored to themselves and their learning process. This takes place in the ★-group through the teaching of basic subject content and the promotion of profession-related language. In addition to knowledge, technical language is a central component within the concept of deeper learning (Meyer et al., 2015). Learners in this group show a high deficit in writing and language skills, which serves as a basis for promoting these skills with exercises and strategies. According to §2 para. 11 SchulG, the higher-performing learners are to be challenged and supported through more challenging tasks. The promotion of these students takes place in the ★★-group through tasks that offer more difficult subject content and a higher language level. As in the ★ group, the focus on language and subject knowledge is based on the concept of deeper learning (Meyer et al., 2015).

A learning structure grid is used as a diagnostic tool for assigning students to the respective group; see Annex A. In the y-axis six different levels with operators are documented, whereby the degree of difficulty increases with each level (Anderson, 2001). The operators have also been selected according to the complexity of the technical language (compare Meyer et al., 2015). The x-axis represents the complexity of knowledge in five increasing levels (QUALiS NRW, 2023). Within the learning structure grid, a differentiation matrix is depicted, showing support and extension levels according to Wember (QUA-LiS NRW, 2023). The students are assigned to learning groups based on language level and subject knowledge. The basis for the assignment is tests and classroom observations. The expected acquisition of competences is documented in the grid for each lesson.

4. Course of the learning situation

Lesson	Step / activity	Topic of the lesson
1	Inform, analyse, plan and decide	Decker GmbH would like to realise the project clamping device" - Preparation of a work plan for the transparent design of further lessons on the basis of an analysis of the initial problem
2	Perform	Decker GmbH would like to realise the project clamping device" - Preparation of a work plan for the transparent design of further lessons on the basis of an analysis of the initial problem
3	Perform	"Where does the compressed air come from?" - Assignment of the individual components of a piston compressor
4	Perform	"What is the function of the individual components of the service unit in our system?" – First analysis of the function
5	Control, rate and reflect	"Checking the work results" - checking, evaluating and reflecting on the previously produced work results
6	Inform and plan	"Feeedback and suggestions for improvement" - recording the sources of errors and formulating suggestions for improvement on the basis of the lessons-learned process.

7	Decide	"Lessons learned" - definition and selection of objectives and measures from the suggestions for improvement and definition of rules for the use of the digital tool Padlet
8	Perform	What is the function of the individual components of the service unit?" - Analysis of the function of the individual components
9	Perform	"Lock position or flow position?" - Elaboration of the functioning of directional control valves
10	Perform	"Single-acting cylinder or double-acting cylinder?" - Working out the 2 types of pneumatic cylinders
11	Perform	"Development of a pneumatic circuit diagram" - Development of the plan for the pneumatic clamping device
12	Perform	Accident prevention - development of rules and practical tips for the realisation of pneumatic control systems
13	Perform	Assembly of the pneumatic tensioning device with the help of the circuit diagram and explanation of the functioning of the system.
14	Control, rate and reflect	Completion of the project - checking, evaluating and reflecting on the work results
15		Test

5. Didactic considerations for a selected lesson (assembly of the pneumatic clamping device)

In this lesson, the assembly of the pneumatic clamping device is implemented as a topic. In the lesson, the students produce in groups two products each. These are the installation of the pneumatic system and a photo or video of this installation with further information.

The pneumatic clamping device represents a real outcome. Students find it easier to learn with objects (Wiater, 2014). An object, a model or a pictorial representation additionally increase the students' motivation (Wiater, 2014), which is why the clamping process of the clamping device is visualised with a picture of a drill and a clamping jack. In addition, the set pneumatic solution differs for each group, which enables the implementation of differentiation.

With a 3/2-way valve and a single-acting pneumatic cylinder, the ★ group has much less complicated pneumatic components to implement than the ★★ group with a 5/2-way valve and a double-acting pneumatic cylinder. The complexity for the ★★ group is characterised by a larger number of connections for the previously mentioned components and a more complex operation of the pneumatic control system.

Language and writing skills are promoted in the ★ group by assigning terms and designations to the pneumatic device and by connecting and attaching (partly prepared) descriptions concerning the functionality of the system. The connecting of partly given sentences and matching terms is illustrated in Annex L (Phillip, 2015). This measure works as a writing exercise and a learning strategy for learners to reduce deficits in writing skills (Phillip, 2015). Further support for writing skills is included in the reflection sheet.

Guiding questions are provided in the reflection sheet to guide and support the students (Phillip, 2015). Compared to the ★ group, the ★★ group is given no further support, which requires a higher level of writing (Phillip, 2015). Language competence is promoted in cooperative and communicative collaboration using the partner work method (Phillip, 2015). This becomes clear in the presentation phase, among others, as each student has to present his or her work result to his or her new partner and answer questions. The cooperative collaboration in the elaboration, presentation and discussion phase additionally promotes the social competence of all learners, as each learner has to communicate in each phase (Phillip, 2015).

The higher-performing learners of the ★★-group have to present a video. The self-made video serves as a linguistic product and expands the subject-specific, methodological and linguistic competences for this group (Miesera & Wunram, 2018). The task is not only to name the components, but to explain the functionality of the device in detail.

In the lesson shown, the students use a variety of media. The media represent a part of the communicative competences and thus have considerable relevance (Miesera & Wunram, 2018). Each medium has different functional purposes. While the tablet is a supportive form of media use, the focus of the Classroom Screen and Padlet media is predominantly on media literacy (Miesera & Wunram, 2018). The students use the media Padlet and Classroom Screen as informative support sources, from which information on the subject content, the work results of the other students or the organisational classroom events can be taken (Miesera & Wunram, 2018). The medium Microsoft Word enables media critique through the feedback template, as an analytical and reflexive approach (Miesera & Wunram, 2018).

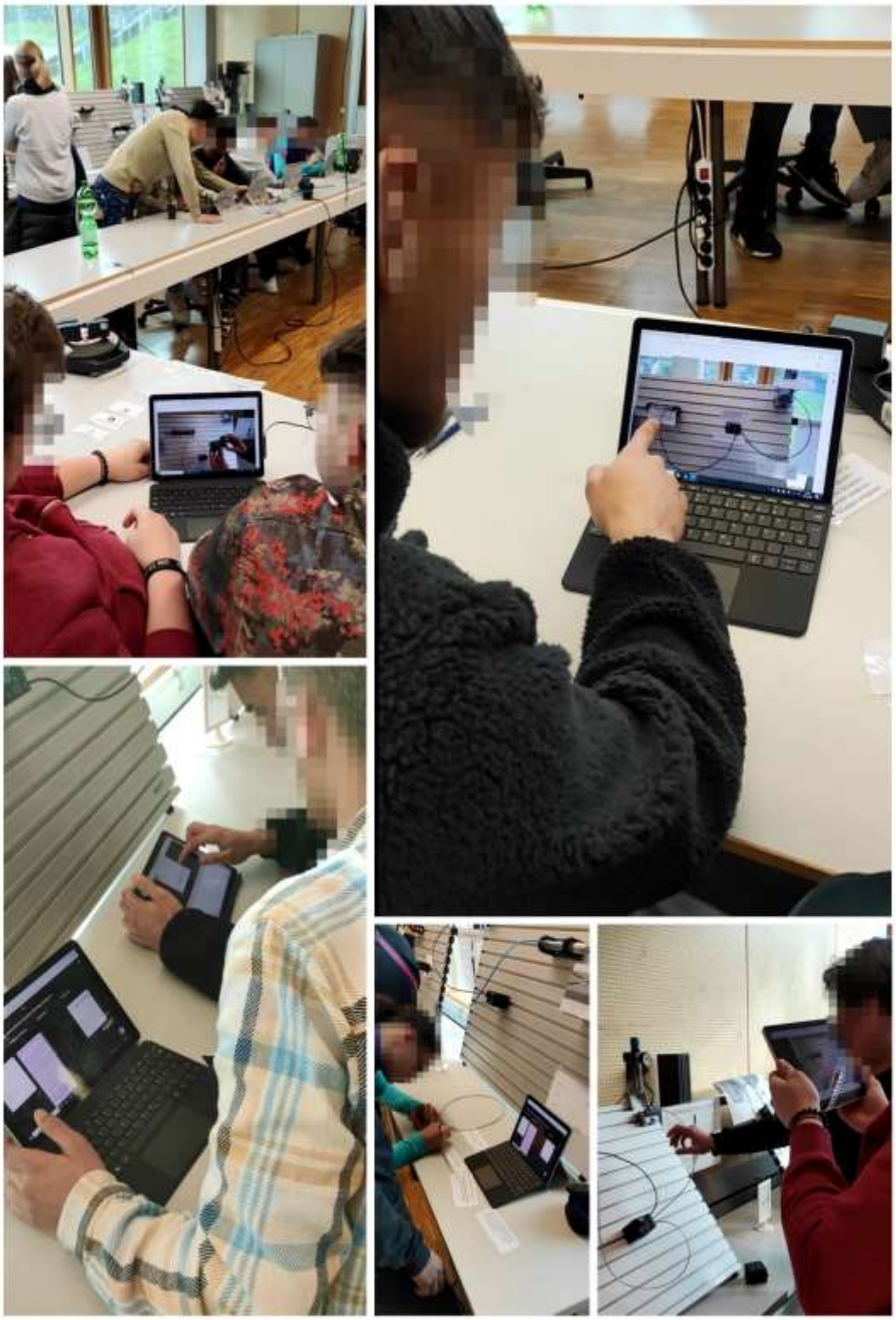
In the elaboration and presentation phase, task cards with different tasks are used (Annex G). The aim of these cards is to increase efficiency in group work (Klippert, 2002). This goal is achieved by creating positive dependencies within the group work through individual responsibilities (Klippert, 2002).

6. Central objective of the lesson

There are two central objectives in total, which are differentiated according to the respective groups.

Objective ★ Group: Students are able to describe the operation of a pneumatic clamping system with support materials by assembling the pneumatic circuit with a single-acting pneumatic cylinder and a 3/2-way valve based on a pneumatic schematic.

Objective ★★ Group: The students are able to justify the use of a 5/2-way valve in the context of a double-acting pneumatic cylinder by assembling the pneumatic circuit with a double-acting pneumatic cylinder and a 5/2-way valve on the basis of a schematic in a short explanatory video.



Some Impressions (Photos Michael Erz)

Intended competence in detail:

The students are able to...

... check the objectives of the lesson based on the learning situation, the digital work plan or the Classroomscreen programme.

... cooperatively assemble a pneumatic clamping device.

... describe the operation of the clamping device with assistance (★ group)

... justify the use of a 5/2-way valve in the context of the double-acting pneumatic cylinder. (★★-Group) in an explanatory video

... present the work results cooperatively with the help of the digital learning platform Padlet and reflect on them using the reflection sheet.

7. Sequence of the exemplary lesson

	Step	**Form of social interaction**	**Media**
Analysis of the problem	The first step is the orientation to work processes on the basis of the work plan (to be prepared) and the learning situation. The students define the problem, the goal and the way to achieve the goal and visualise their reflections on the classroom screen.	Discussion	Beamer, Padlet, Classroom Screen
Elaborate	The students form partner teams (each homogeneous in 2 levels) and assign each other tasks cards. They work on the task in these teams and upload the results to the padlet. Different tasks and additional tasks are available for differentiation.	Teamwork	Task cards, Padlet, ipad, Software Festo Fluid Sim
Presentation	One student of each team changes the group. The students present their work results to each other and ask questions.	Teamwork	Padlet, ipad
Reflection / discussion	The students switch back to the original groups and reflect on the work results of another group using the reflection sheets. The results are uploaded. Afterwards, results (videos, installations) and reflection sheets are discussed in plenary as examples.	Teamwork Plenary discussion	Padlet, ipad, reflection sheet

Reflection / discussion	Students discuss their findings and identify key differences. Alternative technical applications are discussed.	Plenary discussion	

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Literature Learning Structure Grid

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Annex A: Learning structure grid

	Learning structure grid (based on Wember, Kutzer and Polias)				
	Class:		Topic:		
Creating/ Problem Solving [Language] - Students design solutions to problem-oriented issues in a creative form. Students: explore, hypothesise, predict, simulate, take other perspectives, redesign					
Evaluate [Language] - Students discuss and evaluate different issues independently. Students: define, identify, characterise, argue, take a stand, review assess, question, reflect transfer					
Analyse [technical language] - Students systematically and purposefully investigate and evaluate facts. Students: express cause, express effect, draw conclusions, criticise, deduce, transfer					
Apply [relate] - Students apply information/knowledge/skills to specific issues. Students: classify, compare, match, contextualise, categorise, assign, justify			★★ Group: **Competence Goal** The students can install and present the use of a 5/2 directional control valve and a double-acting pneumatic cylinder for the pneumatic clamping device in an explanatory video.	★★ Group**: Additional task** Students are able to compare the current version of their technical solution with other solution variants.	
Comprehension [expressing in own words] - Students describe and structure issues Students: describe, mark, characterise, specify, elaborate, categorise, structure, explain, explain, find examples		★ Group: **Competence Goal** The pupils can install and describe the functioning of the pneumatic clamping device (including a 3/2 directional control valve and single acting air cylinder) with assistance.	★ Group: **Additional task** The students are able to describe the effects on the functionality of the control when the rotary switch of the 3/2 way valve is replaced by a push button.		
Remembering [everyday language] - Students report on facts on the basis of general knowledge. Students: reproduce, report, know, enumerate, name, retell					
	1. grid: Isolated facts, objects, situations, phenomena	*2. grid:* Several facts	*3. grid:* Connections, relationships, processes	*4. grid:* Several contexts	*5. grid:* Ideas, conceptions, models, regularities, rules
Main topics					

Legend of the five levels according to Wember				
Support level 2	Support level 1	Basic level	Expansion stage 1	Expansion stage 2

Annex B: Initial situation

From: Schulz..

Dear Mr. Müller,

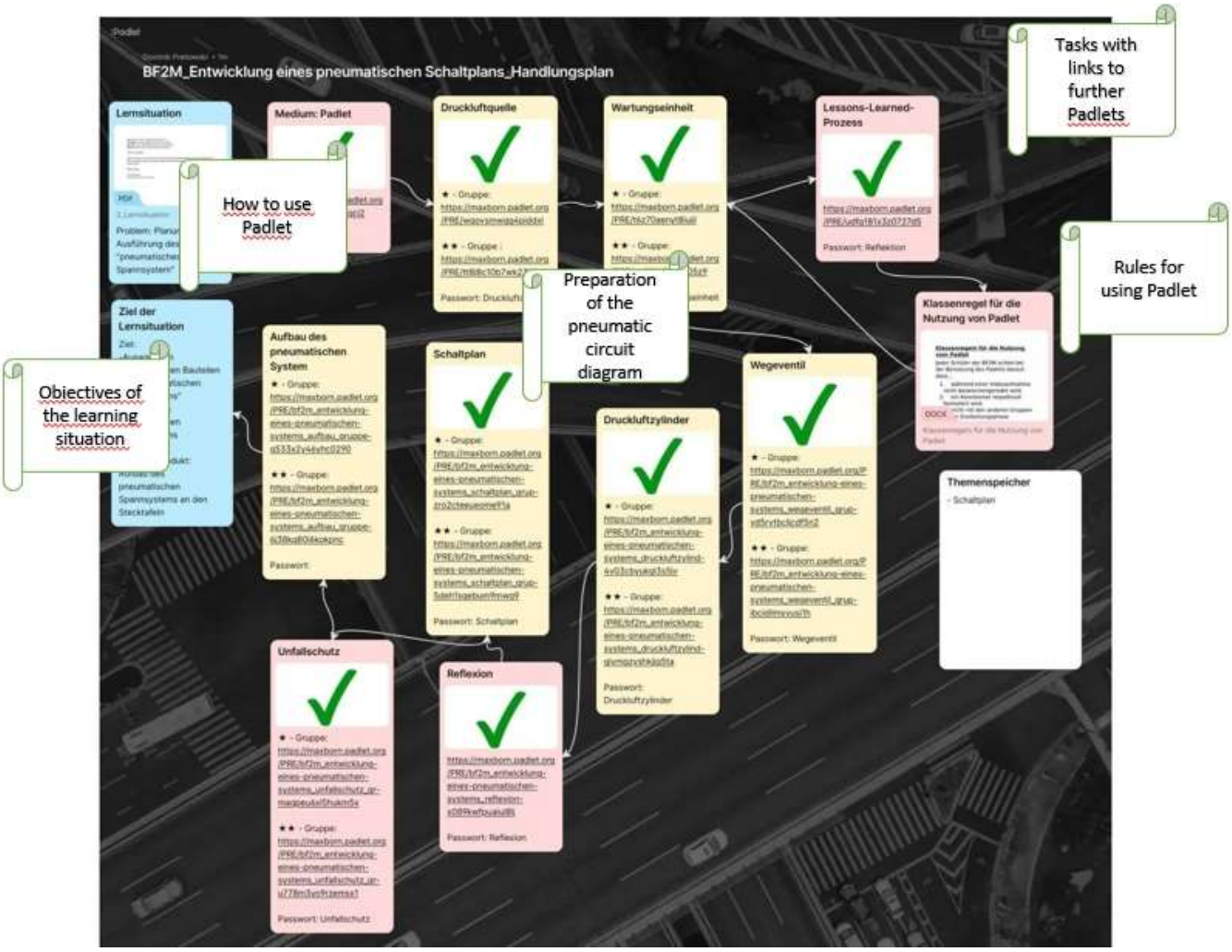
We would like to realise the pneumatic clamping device as soon as possible. Could you please design the pneumatic control using the FluidSim software so that we can manufacture the installation.

With kind regards

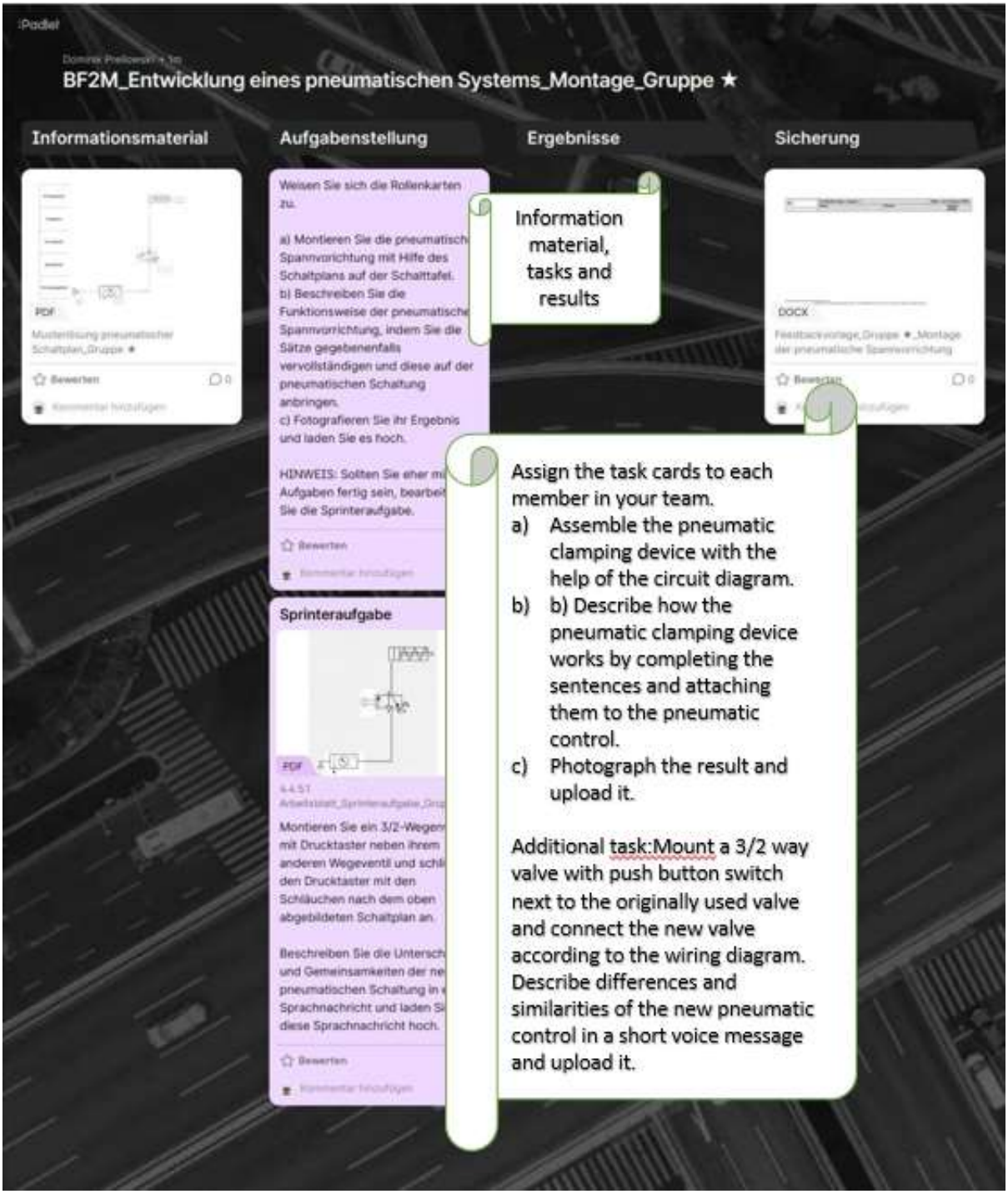
Patrick Schulz

(Production Manager)

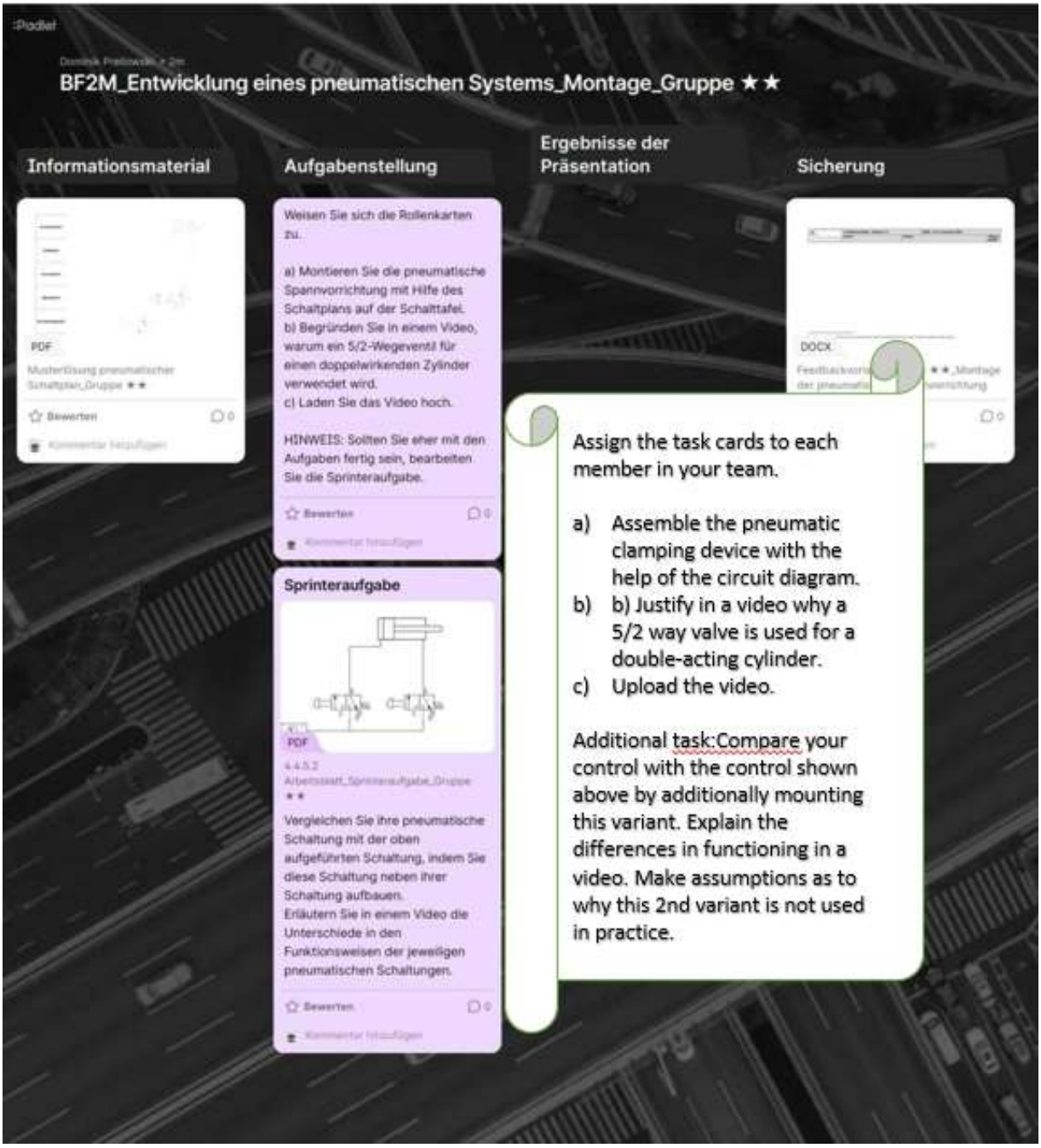
Annex C: Organisation of work and lessons with the help of the Padlet



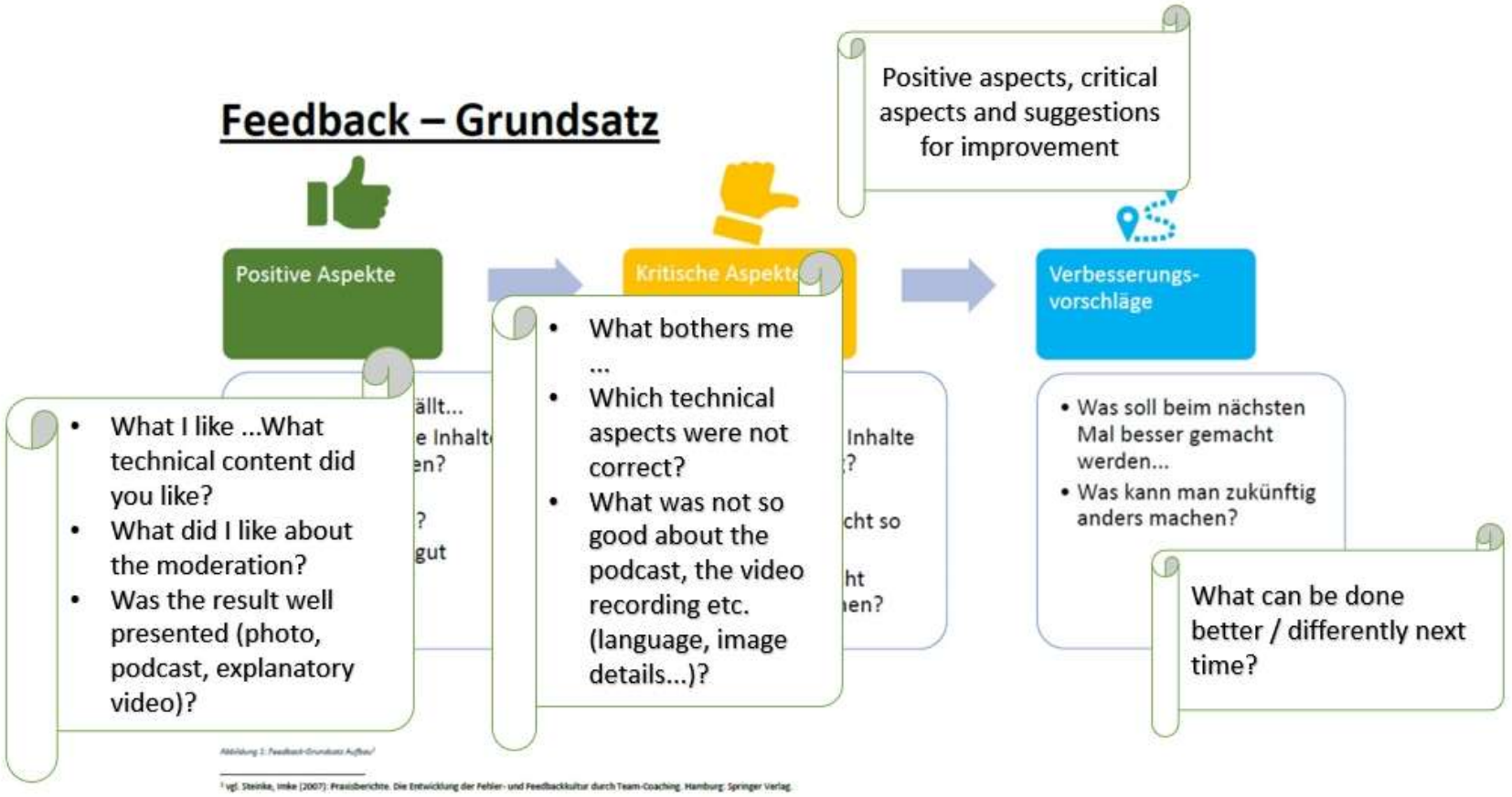
Annex D: Padlet ★ – Gruppe / Work Space



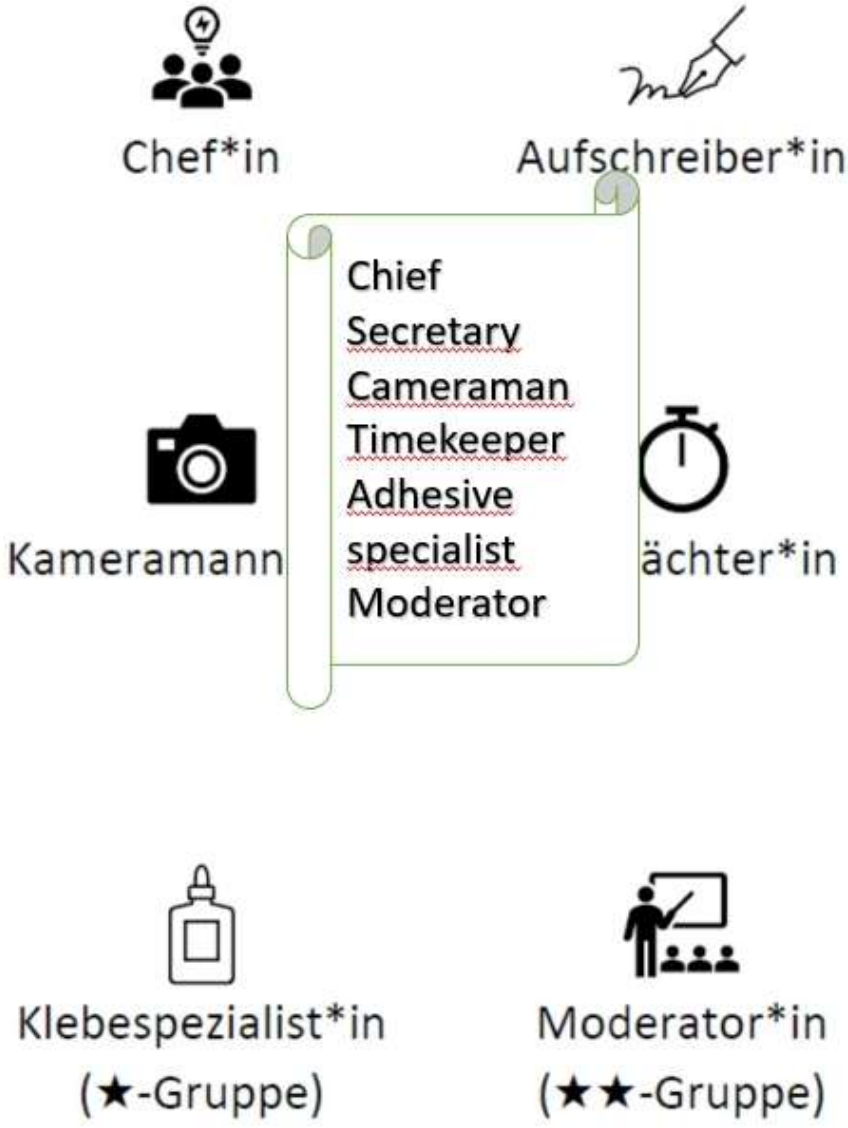
Annex E: Padlet ★★ – Gruppe / Work Space



:Padlet
Dominik Preilowski + 3 • 1Mt.
BF2M_Entwicklung eines pneumatischen Systems_Wartungseinheit_Gruppe
Padlet with results
Wartungseinheit - Informationsmaterial
Wartungseinheit - Aufgabenstellung
Wartungseinhe ALTE Lösung
gseinheit - Lösung
Informationsmaterial zur Wartungseinheit
seinheit
1219
Metalltechnik
6
Pneumatik Grundlagen
YouTube
Pneumatik Grundlagen – Funktion und Darstellung der Wartungseinheit nach DIN 1219
Weisen Sie sich die Rollenkarten zu.
a) Beschreiben sie die Funktionsweise und den Aufbau der einzelnen Komponenten.
b) Erläutern Sie die physikalischen Vorgänge im Innern der Einzelkomponenten.
c) Stellen Sie Ihre Ergebnisse in einem kurzen Erklärvideo dar.
Laden Sie ihre neue Lösung in der zugehörigen Spalte hoch und
Kommentar vom Video mit Pragas und Nandor
Halil: Nandor hat zwar gut geredet, aber die Hintergrundgeräusche waren zu laut, Mein Tipp an euch ist: Ein ruhigeren raum suchen, oder ein Mikrofon von Kopfhörern nutzen
(1) Bewerten
0
Kommentar hinzufügen
komenmtar nandor pragas
Video • 02:27
Nandor und Jake
(2) Bewerten
2
Anonym 1Mt.
das Video ist sehr gut geworden Nandor hat frei gesprochen ,ich fande es gut das Jack geholfen hat bei sachen die Nandor vergessen


Feedback – Grundsatz
Positive aspects, critical aspects and suggestions for improvement
Positive Aspekte
Kritische Aspekte
Verbesserungs-vorschläge
• What I like ...What technical content did you like?
• What did I like about the moderation?
• Was the result well presented (photo, podcast, explanatory video)?
• What bothers me ...
• Which technical aspects were not correct?
• What was not so good about the podcast, the video recording etc. (language, image details...)?
• Was soll beim nächsten Mal besser gemacht werden...
• Was kann man zukünftig anders machen?
What can be done better / differently next time?

Annex G: Task Cards



Die Person notiert die Lösungen oder ruppe.

The person checks the solutions and notes in the group.

Die Person kontrolliert, ob jede Pers

The person checks that everyone is doing their task.

Die Person achtet auf abe.

The person pays attention to the time limit.

Die Person nimmt die E oder

The person records the results as a picture, podcast or video and uploads the result.

The person presents the result behind the camera.

son inter der Kamera das Ergebnis.

Die Person k auf

The person labels the pneumatic control.

Apendix J: Language Support for ★ – Group

Funktionsweise der Spannvorrichtung

Nr.1: Der Drehknopf des _____
regelt die Zufuhr der Druckluft

Nr.2: Die Druc
einheit in den
tils. Der Ansch

Nr.3: Wenn m
ventils dreht,
Anschluss mit
schluss mit de

Nr.4: Der Ans
schreibt die Er tung eines Wegeventils.

Functioning of the clamping device

No. 1: The rotary switch of the ..... controls the supply of compressed air.

No. 2: The compressed air flows from the service unit into the connection of a 3/2 way valve. This connection is marked .....

No. 3: When the rotary switch of the directional control valve is actuated, compressed air flows from the connection marked ..... to the connection marked .....

No. 4: The connection with the mark ..... indicates the venting the venting connection.

No. 5: Compressed air flows from the directional control valve to the ..... air cylinder and the piston rod extends to clamp the component for the manufacturing process.

Nr.5: Die Druckluft fließt vom Wegeventil in den _____
Druckluftzylinder und die Kolbenstange fährt aus, um das Bauteil für den Bohrvorgang zu spannen

Annex K: Classroom Screen

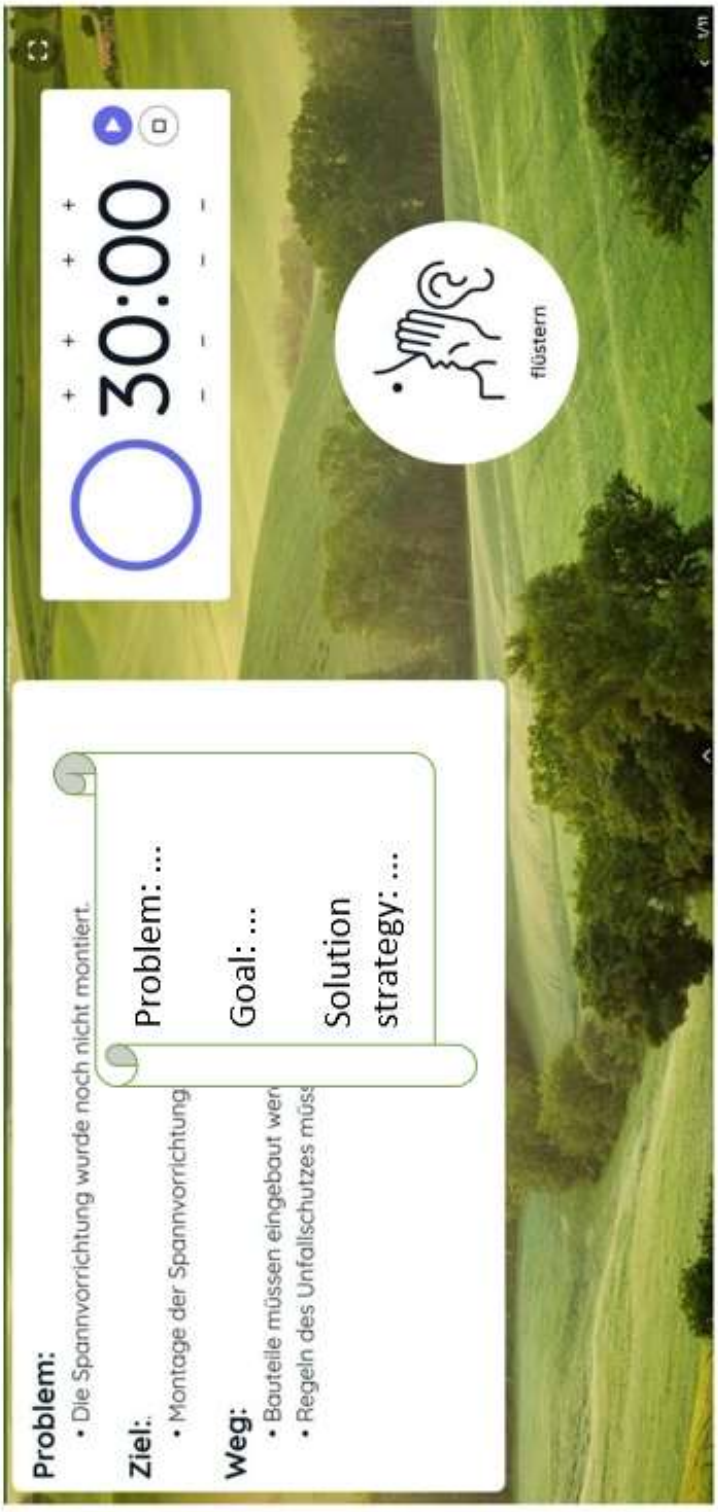
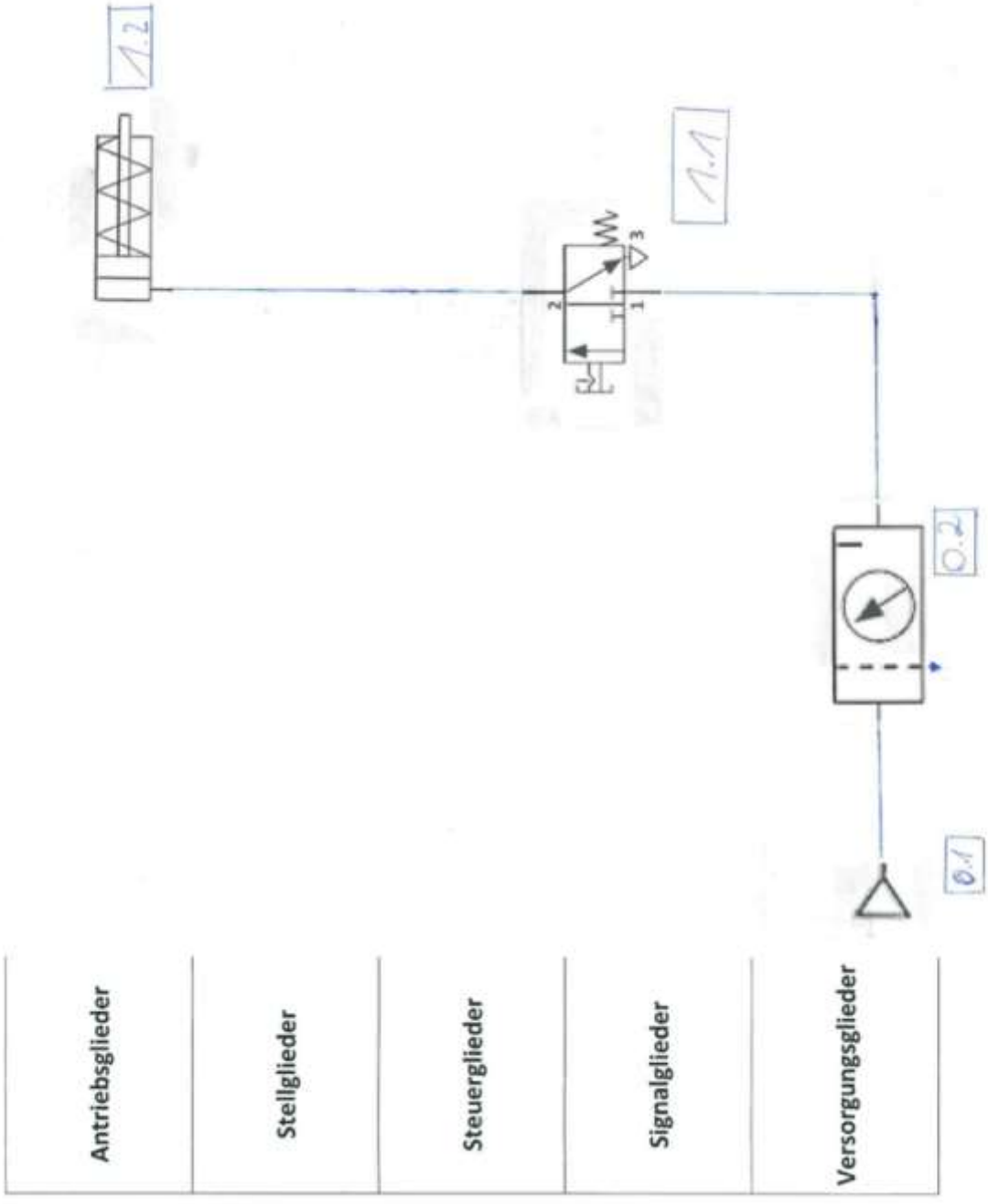


Photo: Dominik Preilowski

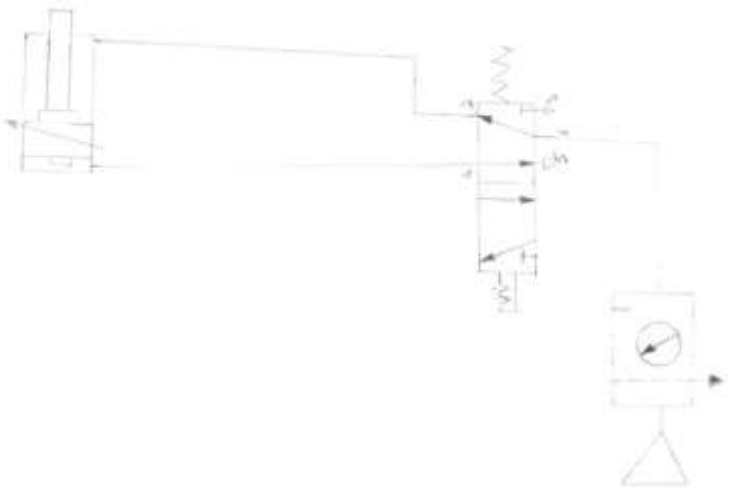
Annex L: Pneumatic Clamping Deevice

Photo: Dominik Preilowski

Annex M: Sample solution of the pneumatic circuit diagram of group ★



Annex N: Sample solution of the pneumatic circuit diagram of group ★★



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