

Walter Kraus | Claudia Munz | Eberhard Escales | Mathias Ueblacker

# FIXING Things for the FUTURE

**A Pedagogical Approach to Teaching Through Repair**  
Ecology, Analytical and Practical Skills,  
Economics, Cooperation, Responsibility

**A PRACTICAL GUIDE TO SETTING UP A  
STUDENT-RUN REPAIR SHOP**

Newly  
Translated  
from the  
German



## IMPRINT

PUBLISHED BY:  
The Student Repair Shop of the Rudolf Steiner School Munich-  
Schwabing

The Student Repair Shop is supported by the  
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<https://www.schueler-reparaturwerkstatt.de>

© for the German edition: Munich 2018, 1<sup>st</sup> edition  
PRINT-ISBN: 978-3-00-060880-3;

© for the English edition: Munich 2022, 1<sup>st</sup> edition  
PRINT-ISBN: 978-3-00-073267-6;

© for the Spanish edition: Munich 2022, 1<sup>st</sup> edition  
PRINT-ISBN: 978-3-00-076789-0;

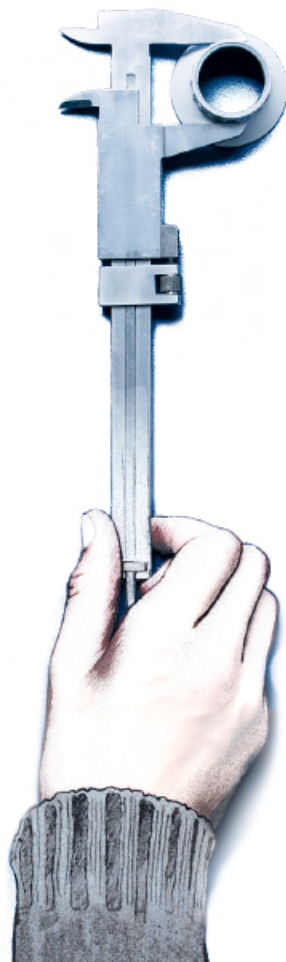
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## Foreword

to the English edition by Vita Wells,  
The Culture of Repair Project

# Forward for “Fixing For The Future”

In scouting around for materials for teaching repair in the classroom, I came across a “practical guide” that a school in Munich had published. In German, naturally, which I don’t read. I ran a few paragraphs through Google Translate and said to myself, “This is good”. Another dozen, and, “This is *really* good”. A few more pages in, and I knew it had to be translated into English.

Walter Kraus with students  
in his workshop



The Rudolf Steiner School in Munich, Germany, has not only established an exceptional Student Repair Shop as part of their regular class offerings for 5th – 11th graders, they've also created a rich handbook to help other schools establish their own repair programs. In the generous spirit of repair communities world-wide, they offer it freely to all takers. Educators interested in repair will find much of value in the handbook, regardless of their project's scale.

What makes “Fixing Things for the Future” so valuable is its comprehensive and integrated presentation. Drawn from the real-life nitty-gritty of the classroom, the guide is rife with the practical nuts and bolts of setting up and running a repair class. These specifics arise from a robust pedagogy that addresses children holistically and are rooted in a philosophy of promoting the well-being of individuals, communities, society and the planet. Celebrated throughout is the sheer delight of learning, sharing, and serving through figuring out the fix with others. Turns out repair's FUN!

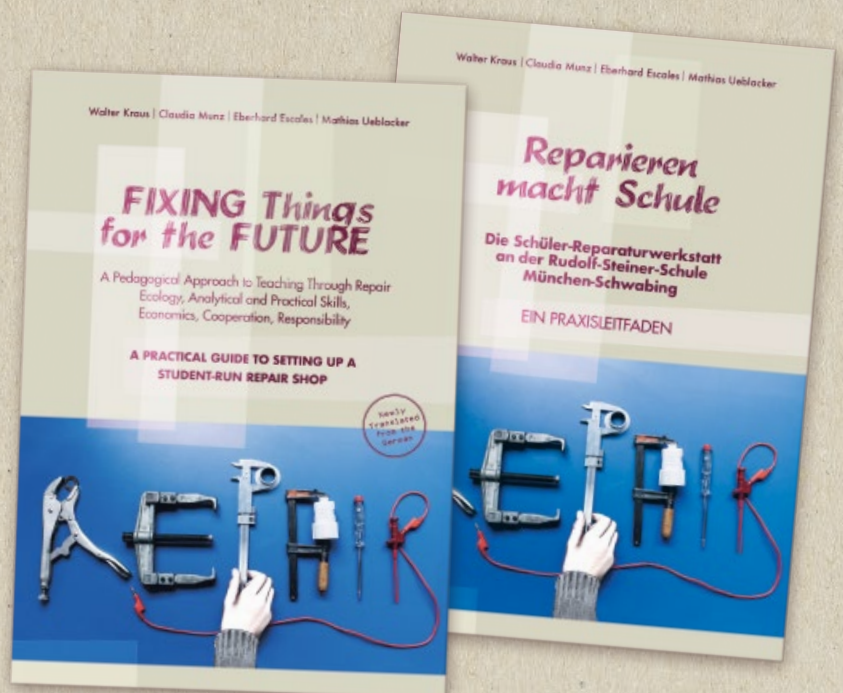
The mission of *The Culture of Repair Project* is for repair to be an actionable and pervasive cultural value. Helping make “Fixing Things for the Future” available to English-speaking educators is consummately consistent with that mission. I was thrilled to come across the guide and am gratified to have played a small part in facilitating its translation.

Vita Wells

*The Culture of Repair Project*

Berkeley, California USA

[www.cultureofrepair.org](http://www.cultureofrepair.org)



# **“I hope that this handbook launches a movement”**

It's always such a great feeling when you've had an idea and are then able to see that idea take root in fertile ground, grow and flourish – even though this may very well involve a lot of work. Since writing my little book *The Culture of Repair*, I've been asked time and time again whether I would give lectures on the topic (yes), whether I would give interviews on the topic (yes), and whether I would be so kind as to repair the gramophone that someone had been nice enough to have already sent me (for goodness sake, no!). And now I have been asked whether I would be willing to write a foreword for this handbook (of which I can wholeheartedly say that there is nothing I would enjoy more!).

Why, you may ask? Because I am especially proud of the fact that the “culture of repair” has found a permanent home in the Student Repair Shop at the Rudolf Steiner School here in Munich.

Furthermore, this project not only dispels the notion that repairing things is exclusively the passion of retired people with a lot of time on their hands, it also dispels the conceit that young people consume things fast and are just as quick to throw things away.

When students discover their own passion for repairing things, the benefits are all the greater because for the rest of their lives they'll be fixing all manner of things rather than tossing them into landfill.





Any time we repair something, we are showing our respect for both nature and culture. When we repair things, we are honoring the fact that a broken but still thoroughly serviceable gadget contains natural resources which we must not simply throw away. At the same time, that gadget represents the cultural achievements of the people who developed and built it which we should not simply throw away either.

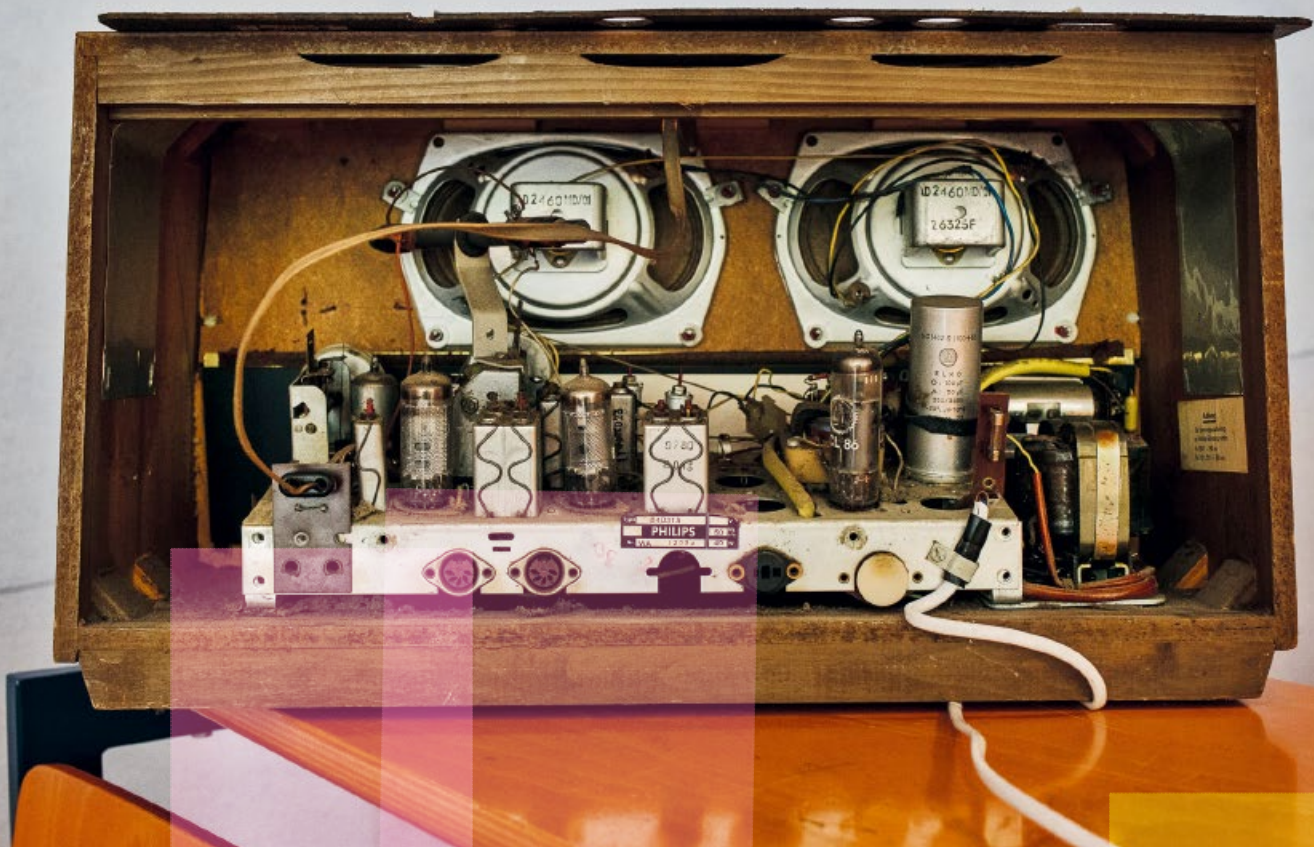
And, of course, repairing things is a lot of fun and tremendously fulfilling. Any time we've gotten something working again, we've also understood how it works from the ground up. This should be taught in schools, and is why this Student Repair Shop and the initiative taken by the Rudolf Steiner School deserve the utmost respect.

I sincerely hope that this handbook launches a movement and that workshops of this kind are set up in many more schools. I hope so for all of us.

**Wolfgang M. Heckl**

*President and Director of the Deutsches Museum, Munich*

Wolfgang M. Heckl  
in his workshop



**“We all gained the confidence to examine things, instead of simply throwing them away”.**

*(Sophie, a 10th grader, talking about the Student Repair Shop)*

# Part I: From idea to project

## 13 “Shaping a meaningful future”

How it all began, what inspired us (and still does)

- Why couldn't an idea like this be transferred to a school setting?
- Our society urgently needs to change its thinking
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- Repairing things is fun and we learn a lot in the process
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Basic ideas behind this approach to teaching

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- Discovery Learning
- Experiential Learning

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# “Shaping a meaningful future”

## How it all began, what inspired us (and still does)

A passionate repairer, Walter Kraus, math and physics teacher at the Rudolf Steiner School in Munich-Schwabing, came across *The Culture of Repair* by Wolfgang M. Heckl. Heckl writes of an idea attributed to Martine Postma, an Amsterdam journalist concerned about the environment and sustainability. Postma imagined laypeople and volunteer experts gathering to repair broken objects in a relaxed atmosphere over coffee and cake. Her Repair Café was the first of what’s become a vast movement – Repair Cafés and similarly formatted community repair events have swept the globe.

## Why couldn't an idea like this be transferred to a school setting?

The “Repair Café” concept was then adapted to fit the needs of the Munich Waldorf School. Since April of 2016, the “Student Repair Shop” has been an elective for the ninth and tenth grades, for grades five through eight at the day-school, and in Technology Education class in the 11th grade. So, twice a week, the twelve students in each of these classes have the opportunity to repair things.

This makes the Rudolf Steiner School in Munich the first primary school in the world to offer repair classes. Supervised by experienced tinkerers (volunteers from the community), students in these classes repair objects and devices of all kinds.

In publishing this handbook, we intend to share our experience and offer guidance to educators interested in repair, with the hope that this highly successful teaching practice is widely adopted.

## Our society urgently needs to change its thinking

Human beings currently consume 60 percent more resources than the world can provide. If things continue like this, as early as 2030, we will need two Earths to meet our needs for food, water and energy.<sup>1</sup> This clearly shows that the Earth has reached its limits and that we all need to change our thinking. An important first step toward conserving our planet’s resources and protecting our climate is to avoid waste.

The objects we use every day have become so complex that many people lack even a basic understanding of how they work. Often, a minor adjustment is all that is needed to get a device working again. We have become so used to replacing things the moment they don’t work the way we want them to, that we no longer make the effort to repair them – although repairing them is often much easier than we think.

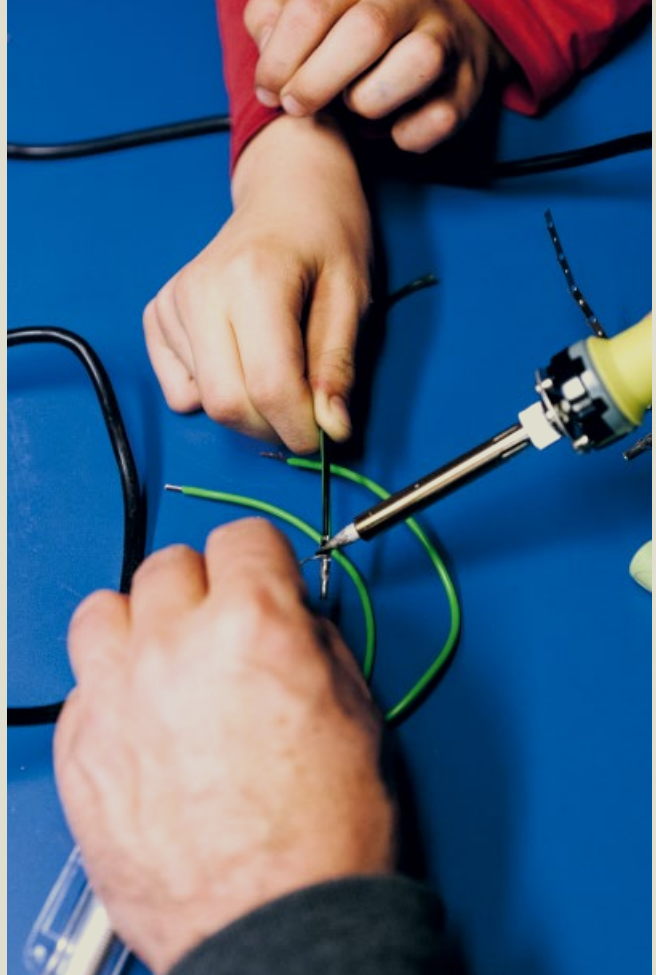
*With student repair workshops, we are shaping a meaningful future:*

*We are fostering the courage to repair things and the joy of repairing them, and we are facilitating environmentally conscious, sustainable action.*

## Fixing things is applied environmental education

In most cities repair shops have become scarce. The cost of labor has become too high and the quality of the materials used in many products is too low to sustain these businesses. Role models who make things have disappeared from our lives, and working with our hands is no longer part of our daily experience.

Repair as a subject taught in schools offers the opportunity to learn about the value, nature and function of everyday objects and to learn about the sustainable management of resources. By repairing things, students learn about, come to grips with and assume their own responsibility for the technological world around them. Practicing the mindful use of energy and raw materials strengthens awareness of natural resources and ethical values.



## Repairing things is fun and we learn a lot in the process

Students are curious; they ask good questions and they have good ideas. Repair encourages them to develop detective skills (how does the housing open?), the joy of discovery (while troubleshooting), the art of improvisation (of repair methods) and communication skills (through interactions with customers and suppliers). Often, a problem will only be due to a loose contact, a dead battery or a broken part.

Repair in the classroom is interesting from an educational point of view because students use discovery-based, experiential learning to find out what is wrong with an object, and to figure out how to repair it. Meanwhile, they're often complementing their hands-on work with using digital media, e.g., repair videos on YouTube and other online resources.

## Intergenerational cooperation and appreciation

The Munich Student Repair Shop is staffed by volunteer repair instructors who enjoy working with others and want to share what they know. These instructors do not, however, give step-by-step instructions. Nor do they immediately offer help. Students need to learn how to figure things out on their own. It's ultimately not the instructor who says whether the student has done well – it's the object: Does it work? Or not? What greater security can one develop in life than knowing: "I can figure this out"?

## Do you have to be a Shop teacher or a Physics teacher to start a repair workshop?

No. Students carry out the repairs, and experienced repair instructors will be there to provide any help necessary. Repair Shop teachers should, however, be passionate about changing from a throwaway society toward a responsible one based on ethical values, so that the planet's remaining resources will be available for future generations.

## Outside perspectives – integrating support from the very beginning

A Student Repair Shop requires more than just a single person or group that takes the initiative. Taking the initiative is good, but getting – and keeping – a Student Repair Shop up and running will require many helping hands. That is why we highly recommend getting external support on board from the beginning. Volunteer instructors have a lot of invaluable know-how, so it's a very good idea to involve them early, e.g. in the planning and construction phases.

The Munich Student Repair Shop also expressly sought “outside perspectives”. We received expert scientific support from sociologist Claudia Munz from the GAB Munich Association for Research and Development in Vocational Training and Occupations. Through participatory observation, she recorded the project's educational outcomes precisely. She provided insight into the educational impact of environmental education, craftsmanship, and interactions with customers. Ms. Munz also observed factors that support individual development during puberty. This scientific monitoring allowed us to reflect on our own perceptions, enabling those who participated in the project to become learners themselves, and preventing us from becoming “operationally blind”. We also recommend networking with other repair initiatives as early as possible.

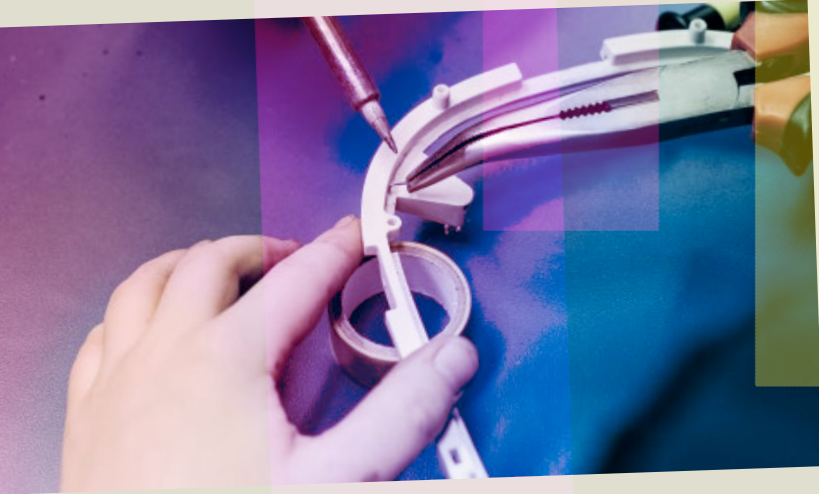


## Ideas, not instructions – what this guide is for

With this handbook, the Munich Student Repair Shop would like to share its experience and to encourage schools to start similar programs.

Because conditions at various schools are so different, rather than being a “cookbook” with instructions to follow step by step, this handbook aims to serve as a guide that can be adapted to various circumstances. We are confident that this collection of experiences, tips and suggestions will enable educators to design a model suited to the conditions at any school. Our goal is to support motivated teachers, parents and volunteers as they embark on their own “road to repair”.

# The task itself becomes the teacher



The Student Repair Shop at the Rudolf Steiner School in Munich has been active since April of 2016. The work done there is based on two main considerations:

A critical look at the consume-and-throw-away behavior prevalent today shows that it is characterized by technical obsolescence<sup>2</sup>, in other words, by a rapid loss in value due to the availability of newer, “improved” versions of any given product. New technologies are being developed at an ever-increasing rate, and devices are often intentionally produced to have reduced lifespans and to be difficult or impossible to repair. This increased production of “disposable” products is symptomatic of the wasteful way that our society regards natural resources. The problem is compounded by psychological obsolescence, or the marketing-driven tendency of consumers to embrace new trends because, even though their existing devices are still thoroughly functional, they are no longer perceived as being “modern” or up-to-date, so should be replaced.

This raises the question of whether practical insight into these connections can be conveyed to students, and, if so, how? It seemed only natural to find out how far the popular idea of the repair café could be applied to a school setting.

Repair cafés are meeting places where people can repair things, either by themselves or with help of volunteers with specialized knowledge and skills. Tools and materials are on hand to repair all kinds of things: clothing, furniture, electric appliances, bicycles and toys. Volunteers with specialized knowledge and repair skills are there to help. In 2020 there were approximately 2,200 repair cafés around the world where folks who know how to fix things got together with folks who don't, and worked together to bring broken things back to life.<sup>4</sup>



This model provided the main ideas that developed into the Student Repair Shop concept: items to be repaired should come from third parties, and qualified volunteer “tinkerers” should be involved.

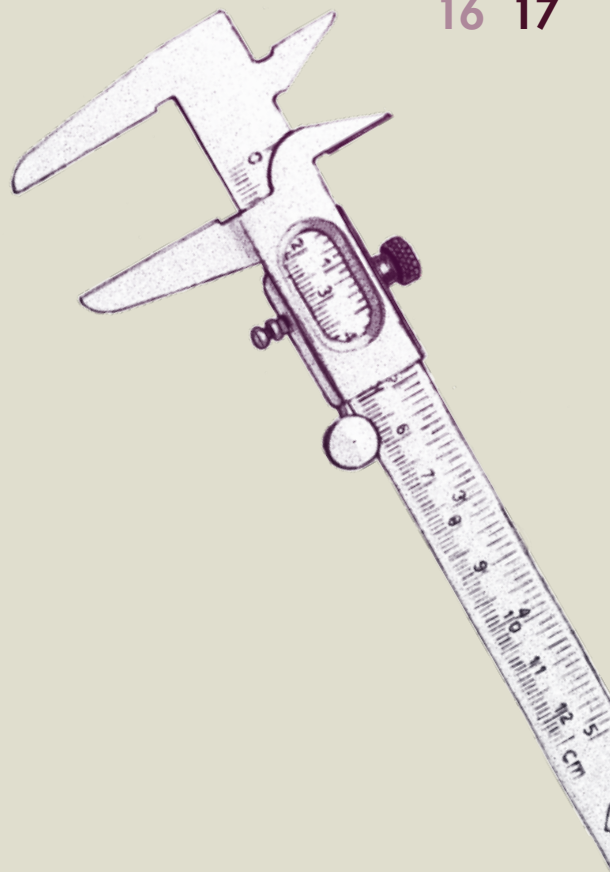
Note: as the ever-increasing number of repair cafés shows, these initiatives are obviously meeting a demand which is no longer being fulfilled elsewhere. Repair cafés are closing the gap between stores and manufacturers usually telling customers that their device “cannot be repaired”, or is “not worth repairing”, and the customer’s desire to have their device repaired instead of having to buy a new one. These repair initiatives, therefore, do not compete with local professional repair workshops.

A number of Waldorf-educational considerations played a role in forming the concept of the Student Repair Shop, in particular the question, “What helps young people who are going through puberty?” One answer is: “learning through practical, useful and unselfish work on real objects”, in accordance with the guiding principle of Rudolf Steiner’s Waldorf educational philosophy “I want to learn, I want to work! I want to work to learn, I want to learn to work”<sup>3</sup>. An interview with Peter Schneider and Hans Hutzl in the German educational journal *Erziehungskunst* (The Art of Educating)<sup>4</sup> sums this up nicely:

*“Rudolf Steiner’s original idea was both social and educational. He envisioned a comprehensive vocational-training school in which learning and working would interact to form the core of the education. Steiner’s approach to vocational training, in which the hands instruct the mind, is well-founded and highly relevant. (...) The task itself becomes the teacher. It is imperative that, rather than simply use civilization’s technology, we understand it.”*

The conviction that young people can “ground” themselves in the world when they understand the technology they use and experience work that is meaningful, comes out of this idea. It is important that this work serves others (see Steiner’s Fundamental Social Law<sup>5</sup>). The value of vocational-training school in building personality comes from the work itself: “my” work is useful to others; and it is satisfying for me because it directly benefits others, and because I can develop through the challenges that the task presents.

An educational concept based on these ideas led to the Student Repair Shop in its current form.



<sup>1</sup> [www.wwf.de/living-planet-report/](http://www.wwf.de/living-planet-report/)

<sup>2</sup> The term comes from the Latin word *obsolescere*, which means to wear out, to get old, to go out of fashion, or to lose standing or value.

<sup>3</sup> Humanistic treatment of social and pedagogical issues, GA 192

<sup>4</sup> “Simply working for other people can be a real challenge”. translation of a quotation in the educational journal *Erziehungskunst*, January 2016

<sup>5</sup> “The wellbeing of the whole of a group of people working together is the greater, the less the individual claims the proceeds of his services for himself, that is, the more he gives of these proceeds to his associates, and the more his own needs are satisfied – not by his services but by the services of others”. Translation of a quotation in: Rudolf Steiner: *Geisteswissenschaft und soziale Fragen*, in: *Lucifer-Gnosis 1903 – 1908*, GA 34, Dornach 1987, p. 213

# What goes into a Student Repair Shop and how to set one up

The Student Repair Shop is open for customers to bring in things that need to be repaired for 90 minutes on one or two days per week. Students ask the customer detailed questions about the item to be repaired and fill in an order receipt form.

An original example of a filled-in receipt of order form. English print version see appendix.

**Annahmabogen**

Datum: 20.11.17      Laufende Nr. 149

Repariert von Schüler      Schüler	Kunde:
Telefonnr.:	Email:
defektes Gerät Küchenwaage Siena Soehnle	Art-No 6594
Welcher Defekt? Geht nicht an	

... mit Kunden: die Geschichte

**Receipt of order form**

Date	Order No.
Repaired by: student student	Customer: first name last name
Telephone no.:	Email:
item to be repaired:	Year made:

What is broken? What still works?

Find out about the customer's relationship to and history with the device. Ask questions like: Why is it important that your device is repaired? Do you associate a special story with the device?

Desired outcome of repair (including date of completion)

Cost of parts (max. )

Consequences of failed repair or even further damage to item

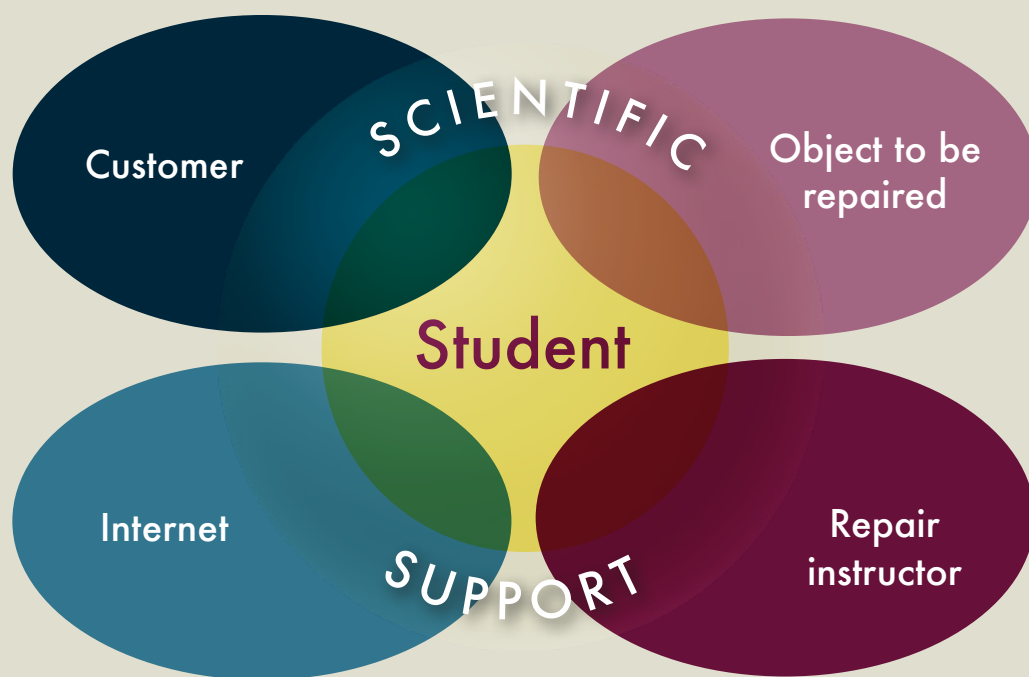
I hereby release the Student Repair Shop from any form of liability, i.e. the obligation to pay damages in the event of a failed repair.

\_\_\_\_\_ Customer signature

Date	Start of repair	Experiences (when taking item apart, broken parts, cause of malfunction) – completed (yes/no), customer comments	preliminary result parts needed + cost
Date			
Date		Experiences (when taking item apart, broken parts, cause of malfunction) – completed (yes/no), customer comments	

**Annahmabogen**

Repariert von Schüler      Schüler
Telefonnr.: 0176/28046797
defektes Gerät Radio-CDPlayer - Kassette
Welcher Defekt? Kopfhörerbuchse (li Seite) ausgebrochen → seitdem kein Geräusch mehr auf der Kassette hören kann.
Klären Sie im Gespräch mit Kunden: die Geschichte des Kunden, die Geschichte des Geräts, die Wünsche und Ansprüche an die Reparatur (z.B. Kosten, Dauer, etc.) Bitte Information, ob weitere Informationen benötigt werden.
Klärung der Ersatzteilkosten (Obergrenze) ca. 30€ (causiert Bitte nachfragen)
Folgen bei fehlgeschlagener Reparatur bis hin zu → Würde dann zu Österreich
Start der Reparatur → 3 Schrauben
Erfahrungen (Zerlegen, defekte Teile, Fehler-Ursache) Zwischenstand, Ersatzteilbedarf + Kosten – Abschluß (p) - Schrauben rausgedreht. - Platine entfernt um besser an c



How the Student Repair Shop is structured

In an effort to keep orders moving, students accept items to be repaired on a first-in, first-out basis and then usually distribute them to two-person work teams at one of the workshop's six work areas.

There are basically three ways that the repair process will proceed, all of which depend on how difficult finding the cause of the problem turns out to be, and how the item needs to be repaired.

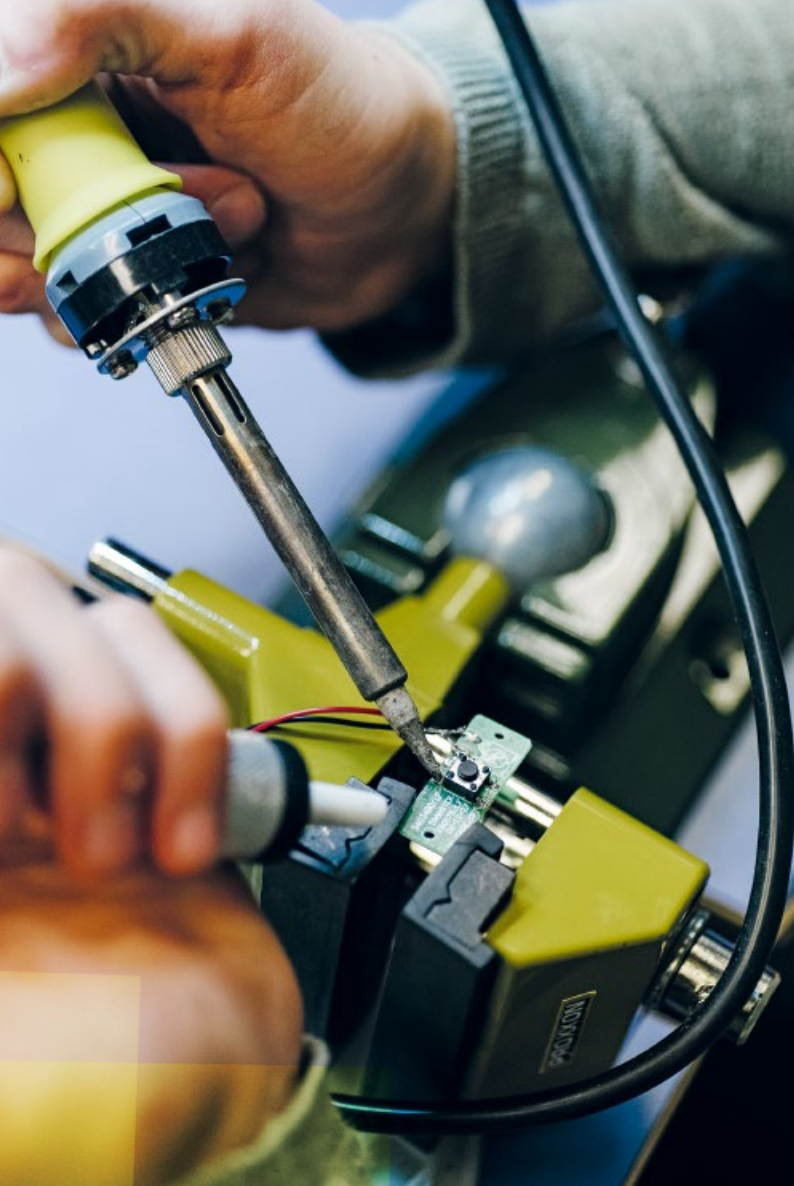
- In simpler cases, the teams will examine the item themselves and try to find out what exactly needs to be repaired. In the process, they will use the various senses (what can they see, feel, hear or smell?) and also draw on prior experience.
- If they are not able to proceed, students will turn to the Internet – to YouTube videos, for example, manufacturers' websites or repair forums – for more information.
- If they still do not find the solution they are looking for, they will ask volunteer experts for help.

Once the cause of the problem has been found, the teams will try to repair the item. If replacement parts are necessary, students will order them, perhaps after first consulting with the customer. More and more replacement parts will be made on-site using a 3D printer.

Aside from any costs for spare parts that may arise, all repairs are free of charge for the customer. Voluntary donations – to be used exclusively for workshop equipment and supplies – are gladly accepted.

The diagram illustrates the Student Repair Shop's dialog-oriented approach: dialog occurs between students, with customers and volunteer repair instructors, and with teachers as well. Another kind of dialog also takes place between students and the objects being repaired, as well as during Internet research (see "The special methodology of the Student Repair Shop").

This dialog-oriented approach also continues with the scientific support that the Student Repair Shop receives. The scientific consultant talks to everyone involved, discusses her observations with teachers and volunteer repair instructors and offers advice if necessary.



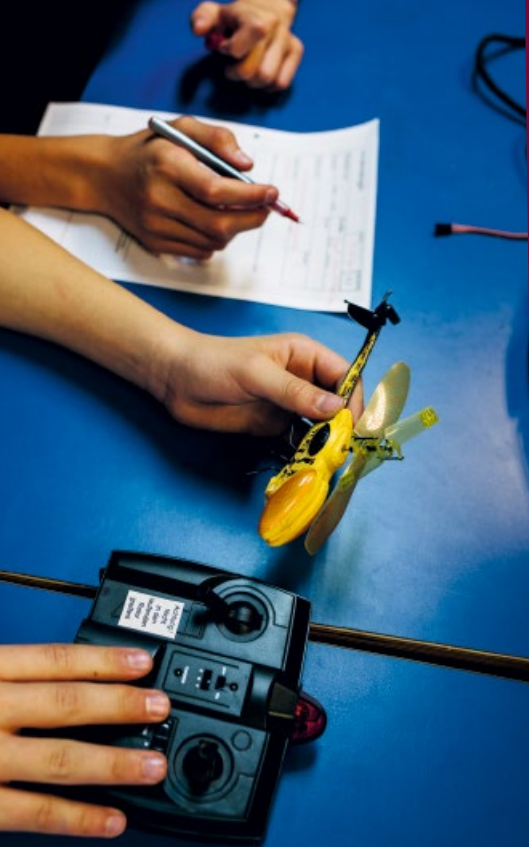
# Real work for real customers

**What makes the Student Repair Shop different from similar approaches.**

Having students work with their hands is not unusual, especially not at Waldorf schools, where the historical craftsmanship movements are part of the curriculum. And these schools, in particular, have developed any number of approaches that make “work as an educational method” available to students.

Along with the Waldorf educational philosophy, the basic idea of “help me to help myself” behind the Montessori educational approach should also be mentioned.<sup>6</sup> And many schools have “student-run companies” – (“training”) businesses in which students plan, produce and sell products or services, even repair services, within the framework of school projects. These usually take place exclusively within a school setting, in which real-life business activities are limited.

<sup>6</sup> <https://de.wikipedia.org/wiki/Montessoripädagogik>



## The Student Repair Shop at Munich's Rudolf-Steiner School stands out through the following aspects:

- Rather than taking place in “safe mode”, real customers bring real objects to be repaired.
- Students shape the entire process on their own: They speak with clients and are responsible, at least initially, for finding out what is wrong, and for doing any research required, on the internet or using other sources (e.g the instructions for use that came with the object). The whole time they are applying discovery- and experiential-oriented methods of working and learning (see “The special methodology of the Student Repair Shop”, below).
- Students decide for themselves whether or not they need help, which they would then actively seek.
- They are also responsible for their own internal organization and for deciding which team takes on which repairs.
- Involving volunteer repair instructors is an integral part of the program; doing so allows students to learn work and share intergenerational experiences with “outsiders”; they do not simply orient themselves on the teacher alone.
- Unlike the usual practice in repair cafés, objects to be repaired do not have to be taken home at the end of “repair sessions”. The objects can stay in the workshop as long as necessary for any parts that may be needed to be procured, and students keep customers informed accordingly.
- The Student Repair Shop is intentionally organized not to be a profitable enterprise. It is much more about putting oneself in the service of others, without expecting material reward. The “reward” comes exclusively from the successful repair and from the satisfaction of having done something for someone else – and having learned a lot in the process.
- Using the Internet as a source of information and as a channel for communication (e.g. with manufacturers and suppliers) gives students the opportunity to recognize the Internet as a resource, rather than simply using it as a means of entertainment.



These characteristics show how innovative the Student Repair Shop is, and they are also to thank for the wide-ranging resonance this new approach has met with. The Student Repair Shop is now part of a large and growing network of repair and sustainability initiatives and has also received numerous prizes and awards.

# Working to learn – learning to work

The methods that set the Student Repair Shop apart

We've already mentioned that we adhere to the methods of “discovery learning” and of “experiential learning and working”.

But what exactly is behind these methods and what were the educational motives for choosing these methods in particular?



## Discovery Learning

“Discovery Learning” is meant quite literally: as opposed to instructional education (explain, demonstrate, imitate, practice), which aims to convey as much as possible in advance about a given task and how to solve it, discovery learning is about finding out about and gaining access to a task and everything that has to do with its solution through one's own initiative. Which is why, among other things, it is called “inquiry-based learning”. This type of learning stands in a time-honored tradition of practical learning and results from the conviction that the ability to act independently can only be learned through independent action, and not through listening and replication. This central idea has been further developed in any number of educational directions, in the New Education Movement (New School) for example, in “hands-on learning” – and especially so, of course, in the Waldorf educational philosophy.



## 11. Die vier Takte des Verbrennungsmotors



Rudolf Steiner always emphasized the importance of the direct connection between doing and learning. His motto for the Waldorf school “I want to work to learn – I want to learn to work!” has already been quoted. If we take a closer look, this motto contains two distinct goals: on the one hand the goal is to prepare young people for the practicalities of life. There are two quotes, known to probably every Waldorf teacher, that stand for this goal. The first has to do with the importance of integrating life’s practicalities into schools:

*“...within the schooling itself, one should have the opportunity to take the practical side of life into account, so that the young person can then translate that which they have acquired in a short time – figuratively speaking – on the model, into practical life”.<sup>7</sup>*

Steiner is more specific where the phase of development beginning with the onset of puberty is concerned:

*“... to introduce people, in a practical way, from the moment they pass through sexual maturity, into those aspects of life which have been created by mankind itself”.<sup>8</sup>*

But this is also about the way that students should engage with these practical aspects of life – namely “through discovery”.

*“You have to do this in such a way that the children are curious about their assignments. If you give the children assignments that make them curious about what they find out for themselves, it stimulates them”.<sup>9</sup>*

Because this way, not only do they learn something practical from a specific assignment, they also gain a general approach that can be used for other, unfamiliar tasks (today, among other things, we call this transfer- or meta competency):

*“In school, we don’t actually have to learn so that we can do what we have learned, we have to learn in school so that we will always be able to learn from life”.<sup>10</sup>*

This is also expressed in an aphorism by Georg Christoph Lichtenberg:

*“That which you have to invent for yourself leaves a trajectory in the mind that can be used on other occasions”.*

Learning through discovery is not, however, “just another” method. It corresponds with the natural learning that we observe in children, and it is a method that anyone who has ever learned, for example, to ride a bicycle, will be familiar with: No matter how many books you have read about riding a bicycle, in practice you can only learn to ride by getting on a bike and trying to stay on it. Finding out the best way to go about it is what gradually builds confidence.

Ideally, in the process of learning through discovery, connections with the world, social- and personal connections will be joined together. Experiences such as wonder, motivation, and the joy of having figured out something new by yourself are characteristic of this process. Learning by discovery is learning with “your head, your heart and your hands”.

In the context of the educational concept behind the Student Repair Shop, however, it is significantly more important that discovery learning leads young people to experience for themselves what it is to manage to do something entirely on their own. And that they also experience that they can get to that point entirely by themselves, without any instruction from adults.

In addition, through their own actions and along the path of “teaching through the object”, they gain new insights into the ways things are interconnected. And thus we promote the “full circle from knowledge to insight” that Rudolf Steiner calls for, starting at adolescence, as well as a feeling of “self-efficacy”<sup>11</sup> – the basis for the ability to do things on your own.

<sup>9</sup> *ibid.*, p. 68 (from a lecture given on April 28, 1922)

<sup>10</sup> translation of a quotation in Steiner, Rudolf (1991): *Die seelisch-geistigen Grundkräfte der Erziehungskunst*, Dornach, p. 22

<sup>11</sup> The term was developed by Albert Bandura in the 1970s. According to Bandura, the expectation of self-efficacy is characterized by the fact that a person is convinced that he or she can perform actions successfully on the basis of his or her own competencies. Such people are therefore more confident in themselves, are capable of more perseverance in overcoming challenges and are less prone to anxiety.



## Experiential learning

*Discovery Learning* is the methodological basis, but by focusing on aspects of how things are done, *experiential learning* defines this learning more precisely, and it is also an aspect of learning that doesn't usually get that much attention. It is precisely this aspect, however, that plays an important role when repairing things. Because the cause of any given problem often isn't clear at the outset, and the way to successfully repair things can't always be foreseen in advance, repairing things calls for a highly developed "tinkering" competency. In such cases, the standard approach of "plan each step and then carry out your plan" often doesn't work. Instead, we have to find out what the next steps need to be through trial and error. In essence, this is exactly what experience-oriented learning seeks to achieve.

Experiential learning was developed on the basis of research by Fritz Böhle et. al., who examined the factors that distinguish the ways that particularly experienced workers do things. They wanted to know how the "special touch", the special intuition of these experts, can be put into occupational-science categories. To this end, Böhle et. al. analyzed how the experts use their body and their senses, which thought processes play a role, what their approaches to action are like, and how particular relationships to the objects being worked on shape the procedure.

Böhle et. al. discovered that, on the one hand, as they had learned it through their training and further education, the "experts" had mastered their area of expertise well.

On the other hand, however, the experts also make use of the entire spectrum of their own personal "assets", i.e. they perceive with all their senses, they think not only analytically but also pictorially and associatively, they proceed, not according to a strict, pre-prepared plan but by trial and error – "in dialog with

the object of their work", and they are also characterized by their own personal relationship to the object of their work. This personal relationship is expressed, for example, in the fact that they have an intimate knowledge of an object's peculiarities and ways of reacting, that they often give it a special name (for example, a production unit was called an "elephant") and that they see the object as a "partner" in a "joint" work process <sup>12</sup>.

So experts use their experience, their tacit knowledge, or, as Michael Polanyi calls it, their "tacit knowing" – and build upon it in the way they do things. This is not, by any means, simply a "wealth of experience" from the past, as one might assume. It could be shown that the workers also open up current experiential possibilities by "making the object of their work 'speak'" in various ways, thus receiving clues for the best way to proceed. For example, they will make minor changes and observe how the object reacts, or they will examine it by touching it, tapping on it, etc. Here, then, it is a matter of active experiencing, in the present. But that's not all: the experience gained in

this manner also enables the "experts" to anticipate impending changes, such as malfunctions in certain processes, even before the item's own displays, for example, would indicate that this is the case (which gives the experts' experience a future dimension).

In the Student Repair Shop, students are explicitly supported in using their sensory perceptions when troubleshooting and repairing. They are encouraged to look out for particular smells or other perceptible symptoms a defective device might have: is there any scorching? Does the device sound strange when it is switched on? They also learn how not to simply work on a device, but to find out what needs to be done through dialog with it. Thus they increasingly explore the "answers" that a device will give them in the course of their efforts. In the process, they develop a sense of possible sources of malfunction and of whether they are on the right track with their attempted repair.

<sup>12</sup> see. e.g.: Bauer, Hans G. / Böhle, Fritz / Munz, Claudia / Pfeiffer, Sabine / Woicke, Peter: Hightech-Gespür (A Feel for High Tech), Bielefeld, 2006

# Learning to repair things is competency-based learning

Simply knowing something is not the same as really mastering it, that is, being able to prove that we can do that thing through concrete action. The path from knowledge to ability leads exclusively through our own actions; it requires having to solve complex problems independently. Although individual skills, such as soldering, can be acquired through demonstration, imitation and practice, this approach doesn't work when it comes to tracking down mistakes, reaching agreement as a team, behaving responsibly towards customers and their property, coming up with ideas for repairs for which there is no template, improvising, not getting discouraged by failures, increasing our own perseverance, etc. In order to be able to convey such skills and attitudes, we have to provide situations in which precisely these skills and attitudes are needed. The Student Repair Shop is a particularly suitable place for this: in most cases, it is not clear exactly what the problem with any given object is, so you have to start looking for possible sources of malfunction by using all of your senses, remembering previous experiences, activating school knowledge, consulting with others, and possibly consulting the Internet. And even if this troubleshooting is successful, it is still far from clear whether and how the repair can be successful. Once again, we have to go on a quest, try out different approaches and see how the device reacts. In the process, students not only learn a lot about an individual device and how to repair it successfully. At the same time, they develop skills and attitudes that are transferable to other situations – in other words, they build competencies. This is understood to mean (according to Erpenbeck and Heyse): “[...] *the combination of knowledge and skills necessary to cope with demands for action. Individuals are considered competent if they are able to regenerate currently required actions on the basis of knowledge, skills and abilities*”.<sup>13</sup> And all this is performed by competent people independently, on their own responsibility and in accordance with the specific situation. Competencies are prerequisites for action, i.e. basic abilities necessary to find our way in new, open, unclear and dynamic situations and to take action. Unlike qualifications, which formally confirm a

standard of knowledge according to predefined school or professional norms (report cards, academic degrees, professional certification, etc.), competencies cannot be taught. They can only be developed through our own doing and learning. In this context, the following applies: people are generally capable of far more than is attributed to them by credentials and certificates. Numerous scientific studies have shown that about 70% of what people know and are able to do was not learned in formal courses, but “from life”, by overcoming challenges at work and in private life. Again, the question of how someone actually learns to ride a bike provides a common example from everyday life. You can't learn to ride a bike by reading a book, no matter how good that book is; you have to get on your bike and practice until you can do it, i.e. until you have acquired the “competencies necessary to ride a bike”, which not only involve the technique of riding a bike, but also of how to move safely in traffic, of how to behave responsibly toward others and so on.

Competencies are usually divided into four areas: personal competencies, activity and action competencies, social-communicative competencies and technical-methodological competencies. It is important to note that competencies are not “acquired” once and for all; they are demonstrated (“performed”) in concrete situations. Thereby, it is at best the focus of any one field of competency that can be determined; in order to be able to act successfully in an open, complex situation, components from all four fields of competency are usually required. The path of competency development is not linear, but characterized by “emotionally destabilizing experiences”.

After all, acting in a challenging, unclear situation – such as the repair process – is associated with uncertainty and unknowns. Failures are part of the process and have to be endured, and anything the repairing person did not think or do correctly needs to be analyzed. Previous knowledge and skills usually aren't enough to prevent missteps, and emotions such as anger, discouragement and apathy can

arise as result. Only when a person is willing to deal with these emotions productively and to muster the courage for a new attempt, can new competencies be formed. This new attempt means a step into open and unknown territory. By persevering and by coming up with new ideas and trying out new approaches, we develop new knowledge and skills, new values and attitudes, in short: we develop competencies.

By opening up to repairing things in the classroom, schools offer children and young people the opportunity to experience and do things that decisively expand the usual learning they would receive at school. Even if there are many efforts to focus on action, learning at school generally involves explaining – i.e. teaching – a learning program that has been methodically and didactically prepared by a teacher. The students' task is to absorb the material and store it in such a way that it can be retrieved for tests and examinations. Thus, students are offered "ready-made knowledge" which originated outside their own experience and is at best illustrated by experiments. With this kind of knowledge, there is a clear right or wrong which is then evaluated by the teacher.

In contrast, competency learning in the Student Repair Shop has five essential differences:

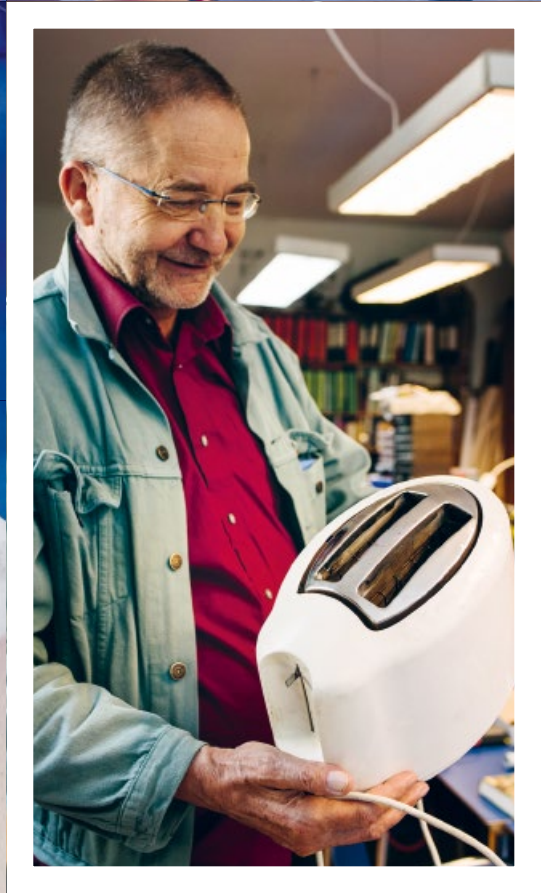
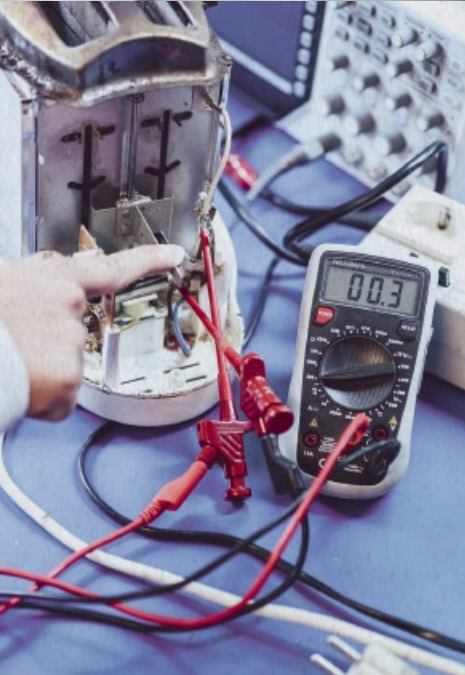
- 1) Work and learning is done on real tasks – the objects in need of repair – these are brought in by third parties, the customers, and the student teams do not know what is in store for them; they become involved in the process through discovering and experiencing.
- 2) There is no clear, predetermined way of troubleshooting and repairing things; the way to do these things is determined in the course of the repair process.
- 3) The process and the result thereof is evaluated by the students themselves, who rely on "answers" provided by the object being repaired and by test procedures carried out on the object.
- 4) Any corrections necessary also result from the process, and the students themselves make the corrections.
- 5) Mistakes and failures are not "wrong" but rather learning opportunities that reveal where an approach or action taken were not enough.





## Here are some key points for implementing this kind of competency-based learning:

- A clear objective and clear formulation of what the individual repairs are to achieve – the conversations that students have with customers when they bring items in to be repaired and the results of these conversations which the students then record on the receipt-of-repair forms primarily serve to meet this objective.
- Students have room to maneuver in how they want to approach the task, so the path to successful repair – aside from necessary safety measures – is open, and students have to find out for themselves what that path is.
- Mistakes and “missteps” may occur along the way – these are expressly permitted as a source of learning. The point is to let the students come up with solutions, background knowledge and an understanding of the facts – for themselves and as much as they can.
- In the process, students should be deliberately using their senses, their previous experience and their associations, etc. to reach their goals.
- Students decide for themselves when they want to get help, either from the Internet or from the volunteer repair instructors.
- These volunteer instructors primarily serve as companions throughout the working and learning process – they follow events closely and only intervene on their own initiative if they notice serious errors.
- Volunteer repair instructors support students with helpful questions and provide motivation when a student’s resolution threatens to fail them.
- The volunteer instructors also help students to realize all the new things they have learned from working on their repair tasks: things that have become clearer to them, successful paths that could be useful for similar repairs in the future and ways they were able to overcome their own reservations.
- The significance of the task itself is the most important motivating factor: after all, we are talking about real repairs for real customers who are really happy when their devices work again.





# Insight into the Student Repair Shop

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The educational outcomes of the Student Repair Shop
- Practical life skills
  - Knowing how to help themselves – finding creative solutions
  - Working methodically
  - Sustainability, resources, and consumer awareness
  - Using the Internet as a tool
  - Transfer of content from other subjects
  - Differentiated perception and a "feel" for things
  - Learning what (really) matters
  - Personality development
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- 50 **My daughter now has the confidence to tackle things that even I would be hesitant to do – things I would need to read the instruction manual three times for.**  
What do parents think about the Student Repair Shop?
- 54 **"You've really accomplished something!"**  
Feedback from customers
- People are enthusiastic about the idea of repairing things
  - The Student Repair Shop encourages sustainable behavior
  - "I'm very attached to it"

**"Handing the repaired device back to the customer was a highlight."**

(Student, 10th grade)



# "Yes! We did it!"

## A typical day in the Student Repair Shop

Now that we have provided a brief overview, we'd like to describe what goes in a typical Student Repair Shop class, based on the extensive notes taken by our external participating observer.

It is 10:15 on a Monday morning, and twelve 9th and 10th graders, approximately the same number of girls and boys, have gathered in the Student Repair Shop. There are six work stations here, each with space, tools and testing equipment for two students to work. On a shelf, there are items that have already been repaired and are ready to be picked up by their owners, other objects that were recently dropped off to be repaired, and still other objects which students have already started to repair and will continue to work on today.

The students are greeted by the teacher in charge and by the volunteer repair instructors, and asked to sit in a circle. In this opening forum, each student reports on their experiences with the repairs they worked on during the last class. Here are some examples of what students actually reported:

**Sophie:** Amelie and I repaired a CD player with – according to the customer – a broken drive. After a while, we found out that that wasn't the case. With some cleaning and readjusting, we were then able to repair it successfully.

**Benedikt:** I fixed a little battery-operated dancing bear. I cleaned the battery compartment, and got it working again. But it only worked for a minute – now I have to go back and see what the problem is.

**Sammy:** I received a coffee machine that was leaking. Unfortunately, I couldn't get the housing open. Then I looked on the Internet for advice on how to fix it, and I was able to get it open.

**Leon:** The iron that I was trying to fix was also really difficult to get open. I did finally manage, though, and was able to start troubleshooting.

**Magdalena and Elias:** We started to repair a broken mixer and the on/off button is broken. Today we have to open it up so that we can fix whatever it is that is causing the problem.



"I've always been curious about repairing things, but I never had the courage to open things up. I am not afraid to do that anymore."

(Student, 10th grade)

The students have just gotten to their workstations, when a customer enters the room; a father pushing his daughter in a wheelchair. They have brought a broken muscle stimulation device that the daughter desperately needs. A student discusses the repair with them, writing down the date the item was brought in for repair, the customer's name and phone number, the nature of the problem, more details about the device, and what to do in case a repair is not possible. Two girls volunteer to do the repair and get right to work, as the customer would like to pick up the repaired device in an hour. The students discover a loose wire, which they solder back on. It works; the repair was carried out successfully – and on time.

Because this repair had been given priority, the teams have to be reassigned. Now one student has to repair a defective power strip by herself, but she feels a bit overwhelmed by the prospect. When this becomes clear, another student volunteers to help her. Together, they are able to fix the problem, but the light in the on/off switch no longer works. The boy who volunteered to help does not think that this is so important; after all, the customer only asked for the power strip to be repaired. The girl, however, points out that it is important to see whether the power strip is turned off or on. She comes up with the idea of putting a ("0/1") label on the switch. When the boy starts to use a pen to label the switch, it occurs to her that a permanent marker would be better.

A two-girl team is busy repairing an electronic car key with a broken contact. After a brief consultation with one of the volunteer repair instructors, the girls decide to solder the contact. They've never soldered before, but that doesn't deter them in the slightest. They put on their safety goggles, test the soldering iron out by soldering on a piece of scrap, and find that they are doing just fine. Now they are able to successfully solder the broken contact, and they are very pleased: "Yes!! We did it!"

The boys' team repairing the mixer has reached a dead end. They were able to get the device open, but now they have to find out what exactly the problem with the on/off switch is. They can see that there are plastic gears inside the mixer and that one of these gears is broken. The repair instructor whose help they have sought asks them what they were able to find out about this plastic material. They answer that it is marked "POM". The volunteer informs them that they won't be able to get a replacement for the gear because it is made of a special industrial plastic. The students ask whether it is worth trying to glue the broken part back together. After discussing which glue might be appropriate for the task, the students get down to work. They are very careful with the delicate part; this job requires a great deal of manual dexterity. They then successfully glue the part back together. When the glue has hardened enough, they put the mixer back together and call the teacher over before they test to see if it works again. It does, and the team is pleased.

In the meantime, another customer has arrived. She has brought a broken toaster. As a matter of course, a student who can easily take a break from what she is working on takes it upon herself to talk with the customer. The "toast" button that starts the toaster no longer works. When filling out the receipt of order form, the girl asks about the customer's "relationship to the item to be repaired". The customer tells her that, even though she has another toaster, she is very attached to this older one because she likes the design better, and because she associates many fond memories and positive emotions with it, she would like to have it repaired.

While all this is going on, the other teams are concentrated on their own repair tasks. In the course of repairing an electric iron, the teacher receives a perfect opportunity to provide some background on the physics of electricity. This is brought on by a short circuit when the teacher turned the iron on – thanks to the safety

precautions (see below), there was no danger. The student makes another kind of connection: "the short circuit was obviously caused by parts that came into contact with one another. Before we do anything on the device, we need to make sure that all the pieces are separated from one another, so the contacts are not touching".

Shortly before the end of the one-and-a-half-hour-long Student Repair Shop, more customers arrive. This time it is an elderly couple who have brought a broken coffee maker. During the customer interview, they too are asked how they found out about the Student Repair Shop. They openly explain that they are welfare recipients, that they found a brochure about free services in a job center, and that repair cafés were mentioned in the brochure. When, upon further research, they discovered the Student Repair Shop, they decided to give it a try. They also explained that coffee was their only "luxury" and that they weren't able to afford a new coffee maker, so they were relying on the students to repair it for them.

All repairs are photographically documented.

At 11:45, a few minutes before the end of today's Repair Shop class, the teacher asks the students to put everything away. At first, however, lost in their work, they don't hear this request at all. After the students leave, the volunteer repair instructors sit down with the teacher for a brief review of the day's class. They exchange impressions and discuss things that they would especially like to pay attention to during the next class.

# Achieving a "vitalizing sense of reality..."

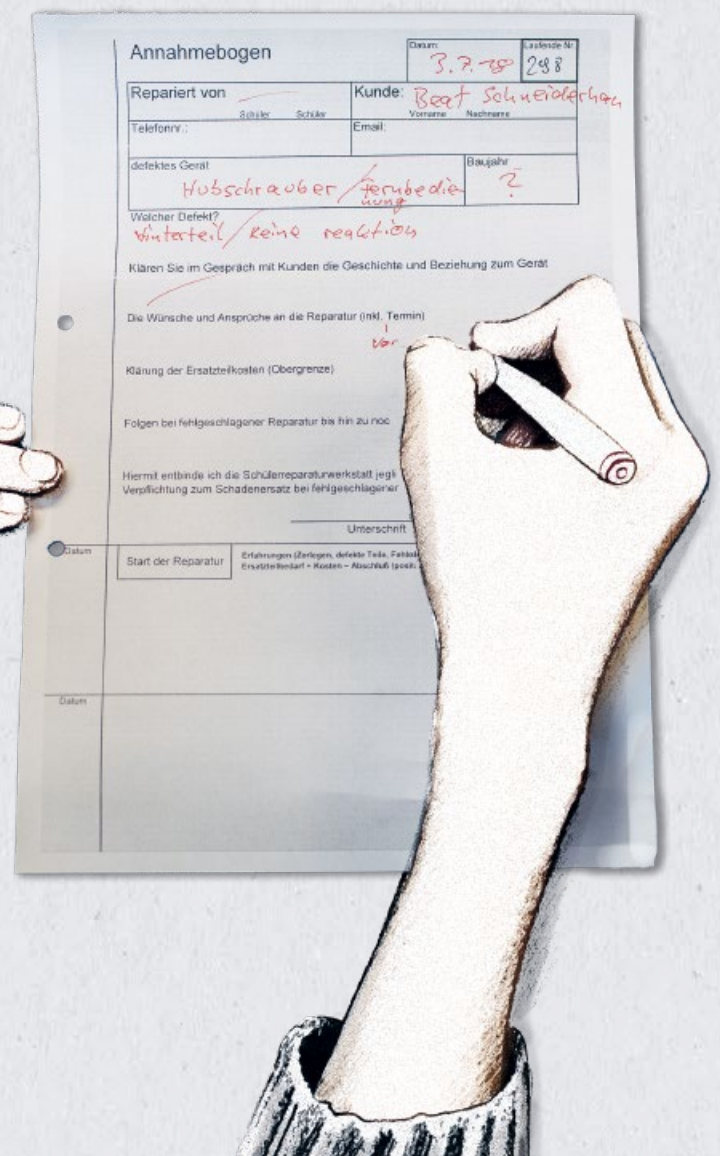
Notes on our experiences with younger students (grades 5 - 7)

To gain a broader basis of experience regarding the possibilities and outcomes of the Student Repair Shop, different grade levels at the Munich Rudolf Steiner School Schwabing were invited to participate.

In an effort to find out whether this course is also of interest to younger students and whether there are any differences compared to older students, the Student Repair Shop has also been offered as an elective for 6th and 7th graders from time to time. In preparation for this, teachers and volunteers had intensively addressed the questions of whether the methodology of discovery-based, experiential learning was appropriate or whether younger students might need more guidance and direction after all, and whether certain repairs should be excluded.

A number of volunteers signed up for each course, some of them with previous experience with handicrafts and repairs. Their enjoyment of these activities was an important factor motivating them to participate.

Our experience with groups of younger students is comparable to the experience already outlined above for the older students. There are, however, a few differences:



The image shows a hand-drawn illustration of a person's hands holding a repair form titled "Annahmabogen". The form is filled with handwritten text in red ink. The form includes fields for date, customer name, defective device, and a description of the defect. The customer is identified as "Beat Schneiderbacher". The defective device is "Hubschrauber / Fernbedienung". The defect is described as "Winterteil / keine reaktion". The form also has sections for the repairer's signature and date.

Annahmabogen		Datum	Kunden-Nr.
Repariert von		3.7.20	298
Stüler	Schüler	Kunde: Beat Schneiderbacher	
Telefonnr.:		Vorname Nachname	
defektes Gerät		Email:	
Hubschrauber / Fernbedienung		Baujahr ?	
Welcher Defekt? Winterteil / keine reaktion			
Klären Sie im Gespräch mit Kunden die Geschichte und Beziehung zum Gerät			
Die Wünsche und Ansprüche an die Reparatur (inkl. Termin)			
Klärung der Ersatzteilkosten (Obergrenze)			
Folgen bei fehlergeschlagener Reparatur bis hin zu now			
Hiermit entbinde ich die Schülerreparaturwerkstatt jegl. Verpflichtung zum Schadenersatz bei fehlergeschlagener			
Unterschrift			
Datum	Start der Reparatur	Erfahrungen (Zerlegen, defekte Teile, Fehlschritte, Ersatzteilbedarf = Kosten - Abschluß (positiv))	
Datum			



Cooperation of generations



- Younger students are more inclined to bring their own things (toys, bicycles, etc.) to repair.
- They are nevertheless just as willing to commit to repairing customer equipment.
- The way that younger students begin to work on the repairs differs slightly from the approach of older students: There is a stronger tendency to act immediately, i.e. the younger students want to get started right away. They start, for example, by opening a device without thinking very much about the device or the problem in advance.
- Younger students' attention spans are shorter; full of energy, they throw themselves into the work at hand, but they can't concentrate as long as the older students can and they are quicker to look for variety.
- Teachers and volunteer repair instructors need to supervise younger students more closely; this is due to safety regulations on the one hand, and to encourage the younger students to keep at their tasks on the other.

Interestingly, however, younger students are no different from older students in terms of their natural and unbiased interaction with much older volunteers and customers. And the pride they take in successful repairs is just as great as it is with the ninth and tenth graders – though the younger students' pleasure is much more obvious – they aren't under as much pressure to be "cool" yet.

Here's an example: A retirement-aged customer brings a defective keyboard in for repair. She had learned about the Student Repair Shop from a brochure for seniors. Her grandson plays the keyboard when he comes to visit her.

A sixth grader does the initial interview and records the customer's answers on the receipt of order form. After a brief consultation with a repair supervisor, he opens the keyboard and begins troubleshooting. It turns out that soldering is needed.

The customer is enthusiastic about the Student Repair Shop and asks to be able to remain present during the repair. For the student, this is no problem at all, on the contrary. When, at a certain point, all the repair instructors are busy with other teams, the student simply asks the customer to help him. And thus, completely by chance, a new constellation is created: the student, the repair instructor and the customer are all working together! The keyboard, now repaired, is handed over to the satisfied customer – who has been a regular visitor to the Student Repair Shop ever since.

Observing how younger students work in the Student Repair Shop over time reveals even more differences. In particular, it turns out that repairing electronic equipment is not really suitable for younger students. The younger students' attempts to repair electronic equipment quickly showed that they were a bit overwhelmed – and that their initial enthusiasm for such repairs diminished accordingly.

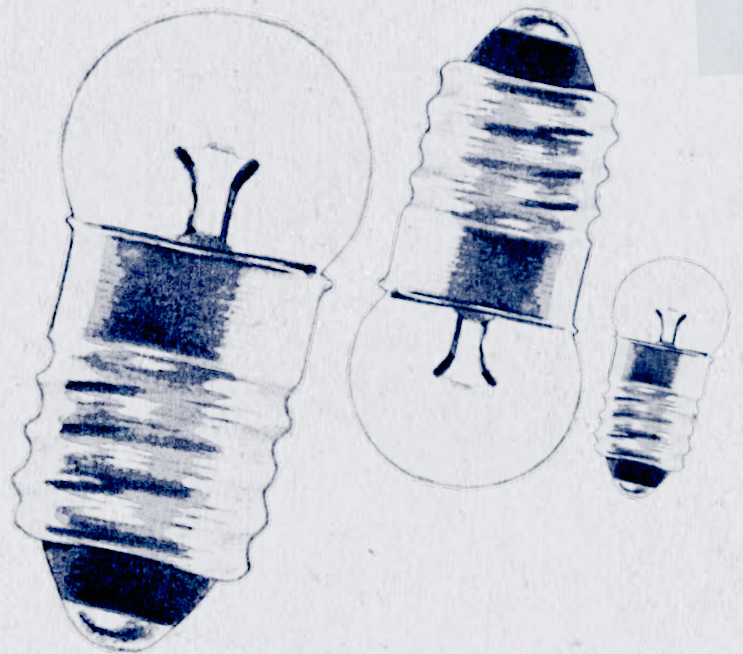
There are several reasons for this: electronic devices are often cheaply produced (remote-controlled toy helicopters, for example), and spare parts for these devices are often difficult or impossible to find. Devices that run on rechargeable batteries, with the inherent problem of these batteries' limited lifespans, have also proven to be unsuited for younger students to work on. The students did, however, get to experience that the attraction that these "cool" toys hold for them quickly goes south when they actually have to repair them.





Far more important, however, is the fact that such electronic devices are abstract objects which students cannot easily troubleshoot by carefully looking at, listening to or touching them, etc. The especially meaningful educational opportunity that the Student Repair Shop presents, the opportunity to locate the source of the problem through careful detection, through tinkering and trial and error, is hardly there at all. So not only do these type of repairs offer little chance to develop the senses, the chance to experience self-empowerment through one's own actions is also missing. And it is precisely these aspects that are so important for young people and so good for their development. This holds true to an even greater extent for younger students. From a developmental-psychological point of view, the differences between the various stages of development become particularly apparent here.<sup>14</sup> Younger students need opportunities to gain access to reality through their senses. For them, the emotional experience of "wonder and enchantment" (R. Steiner) is especially important; without it they can prematurely slide into a jaded and detached relationship to the world and its phenomena. Erik Erikson's developmental concept of "Industry", a child's need to do things that are useful and good, also awakens to an exceptional degree at this age. "Children don't want to merely 'pretend' anymore – now the feeling of being able to participate in the adult world plays a major role". If, however, this participation is marked by experiences of being overwhelmed and of failure, a sense of inadequacy and inferiority may develop during this phase.<sup>15</sup>

In addition, whereas older students are already able to concentrate on one thing for longer periods of time and not be discouraged by setbacks, younger students may not be able to do these things yet – and working on electronic devices does not really offer any opportunity to develop these abilities. From an educational point of view, this is disastrous because: "A growing child must gain a vitalizing sense of reality at each step, by seeing that their individual way of mastering experience (their ego-synthesis) is a successful variant of the ways in which other people around them are mastering experience and recognizing the fact that this is what people do". (Erikson 2013, p. 107)

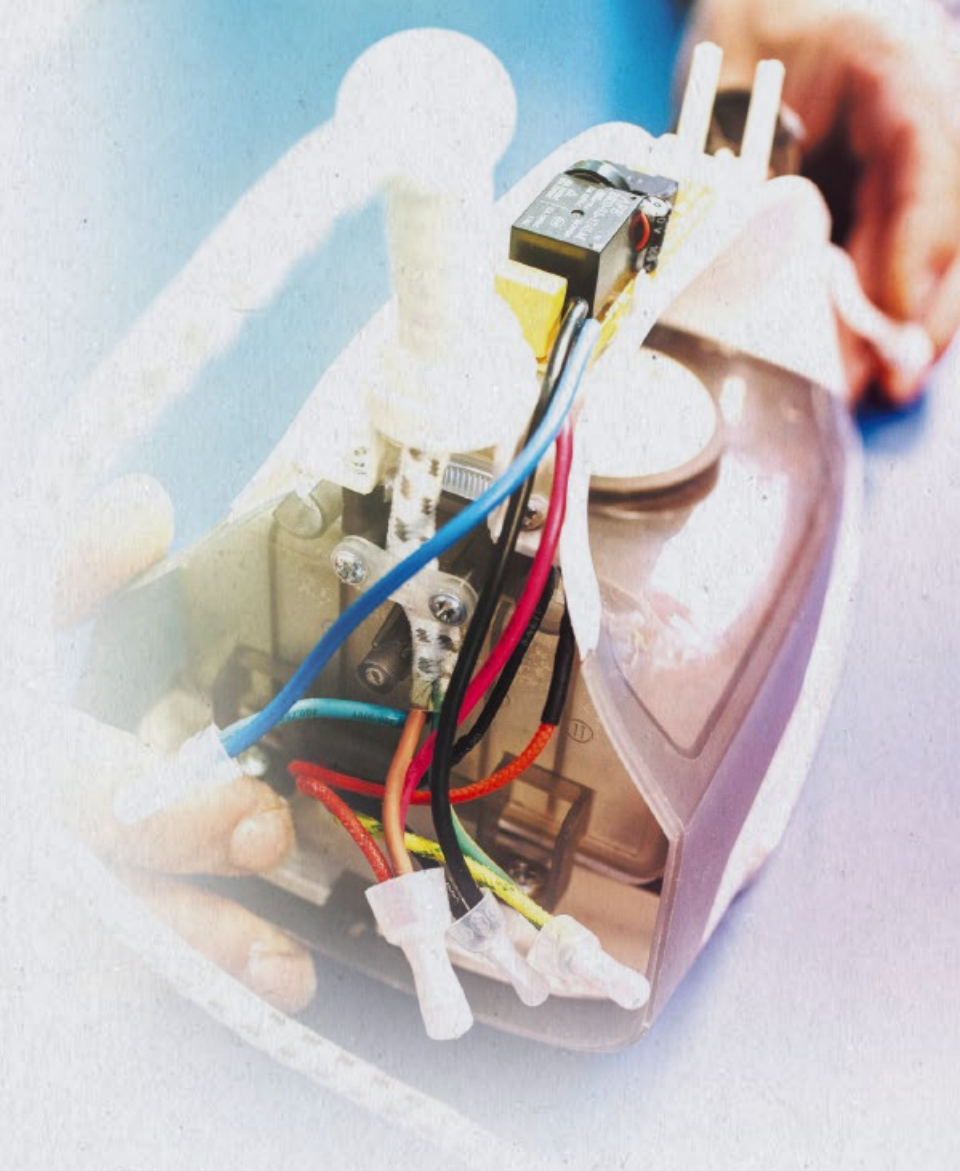


**"Where the customers are concerned, I sometimes find it sad that sometimes all we have to do is change a light bulb, then the device works again. So you can see how important a course like the Student Repair Shop is!"**

(Student, 10th grade)

<sup>14</sup> See also: Steiner, Rudolf (1975): Allgemeine Menschenkunde als Grundlage der Pädagogik Dornach. GA 293 (Lectures of 1919). Literal translation: A General Knowledge of the Human Being as the Foundation of Pedagogy. Published in The Foundations of Human Experience - 15 lectures, Stuttgart; Translated from Erikson, Erik H. (2013): Identität und Lebenszyklus. Frankfurt/M. Also available in English: Identity and the Life Cycle (ed. 1994)

<sup>15</sup> Stangl, W. (2018). Translation from the entry for Erikson's concept of 'Werksinn' ('Industry') in the Online Lexikon für Psychologie und Pädagogik. www: <http://lexikon.stangl.eu/6177/werksinn/> (April 26, 2018)



"I'll figure something out!"

"For me, the most important experience in the Student Repair Shop was how difficult it is to open the devices. You realize that the manufacturers don't want you to do it. And when you finally do get it open, there are only wires in it!"  
(Student, 6th grade)

## The educational outcomes of the Student Repair Shop

The educational outcomes of working in the Student Repair Shop have been confirmed through participatory observation by our independent scientific advisor on the one hand, but they have been confirmed through students' own statements and through teachers', voluntary repair instructors' and parents' observations as well.

### Practical life skills

The first readily apparent educational effect is that the students acquire or develop a number of practical skills. On the one hand, this involves knowing about and how to use a variety of tools and repair resources. For example, many students find out that they need to use different types of screws for working on metals than they do for working on wood. Certain tools hold a special attraction, for example the illuminated magnifying glass stand, which they will examine thoroughly, and through which they will look at their own hands with fascination. Knowing about tools also includes learning the correct names for them – names which the students will then use with visible pride (“Can you hand me a Phillips-head screwdriver, please?”).

On the other hand, students also learn many techniques that are relevant in their daily lives. How to open an appliance that is screwed together, for example, or how to talk with customers; how to order parts, or how to correspond with manufacturers. They also acquire extensive knowledge of materials, various plastics, for instance, as well as of the properties and workability of many other materials. Furthermore, students gain insight into how a wide variety of objects and devices are constructed, how they work, and how they can be repaired.

Interviews show that the fact that they are better-informed brings students satisfaction. It is also important to them that they know more about mechanical interrelationships. The transfer of this knowledge and these skills to their own lives outside of school has also been successful, and many now have the confidence to carry out repairs at home.

### Knowing how to help themselves – finding creative solutions

Every once in a while, there will be repairs which cannot be handled with the available tools and resources alone. In these cases, the students and repair instructors have to come up with another solution. For example, a plastic part has been repaired with tape but needs additional stabilization. A tip from a volunteer instructor comes to the rescue – the students cut a beverage can into strips and use them to reinforce the glue joint. This not limiting themselves to ready-made solutions and instead being creative and trying out new approaches has an important learning effect for these students – the foundation for further “tinkering” has been laid. These experiences are especially valuable from an educational point of view, as they reinforce the feeling of knowing how to help oneself. Far beyond the Student Repair Shop, this basic conviction can be applied throughout a student's entire life; it confers a basic certainty of “I'll think of something”, even when a situation may seem difficult at first.



## Sustainability, resources, and consumer awareness

The subject matter of the Student Repair Shop, namely repairing things instead of throwing them away and buying new ones, represents a central learning opportunity in and of itself. This learning does not take place by being lectured with “ecological arguments”, but by the students themselves experiencing that the vast majority of things can actually be repaired. In addition, through direct customer contact, they gain insight into just how interested many people are in keeping tried-and-tested items and equipment. Moving stories sometimes come to light when students ask about their customers’ personal relationships to the objects they are submitting for repairs. This enables the students to recognize the value of things, including their sentimental value. Students experience that people live with these things, that they are more than mere objects of utility, and that these items often represent a part of their customers’ life stories.

Through many experiences of their own – perhaps most impressively through arduous attempts to open welded housings and through the realization that many of the components inside electrical devices are made of plastic and are therefore susceptible to wear – the students also recognize manufacturers’ strategies (cf. planned obsolescence) to make repairs more difficult so that people will buy new things. Conversations with their repair instructors provide further learning opportunities, for example about the extraction of raw materials and the ecological and social problems associated with that extraction. The Student Repair Shop therefore also provides insight into economic contexts and raises awareness that can be useful for students’ own decisions: do I really need a new device or can the old one be repaired? What do I look for when I actually do want to buy a new device?

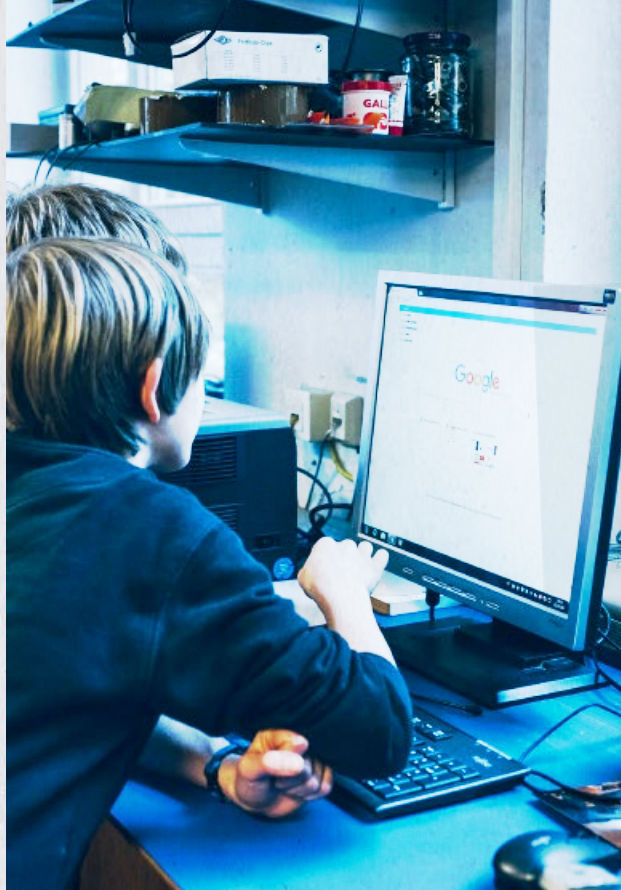
In this way, the Student Repair Shop fulfills the central requirements of the Global Action Programme for Education for Sustainable Development (ESD), the aim of which is to enable learners to “take informed decisions and responsible actions for environmental integrity [...]”<sup>16</sup>

## Working methodically

The insights into the importance of a methodical approach to work, which can be gained in the Student Repair Shop in many ways, are also especially valuable from an educational point of view. These insights are also acquired through the fact that, initially, students often do not proceed very methodically. They may discover, for example, that when they try to reassemble a device, they no longer remember the order in which they disassembled it. Or that they have misplaced the screws that held whatever it is together, and they have to expend a good deal of energy to find them again. Or they may notice that their teammates have not returned a certain tool to its proper place... Discovery learning has proven to be particularly effective in these cases; the students themselves realize that it is worthwhile to proceed more systematically, to curb their own urge to “just do it” and instead to carefully consider the steps they want to take and how they will take them, e.g. whether they will take pictures during disassembly as a memory aid, where they will put the screws to keep them safe and in order, how they will put tools away properly, etc.

This realization is impressively supported by the fact that students can, in a manner of speaking, “watch themselves learn”. They experience their own improvement through how certain hand movements become easier each time, for example, or through how they develop their own systematic way of doing things. This has a far more profound effect than if an adult were to simply tell them why they should be doing things in a certain way!

<sup>16</sup> UNESCO Roadmap for implementing the Global Action Programme on Education for Sustainable Development, published by the United Nations Educational, Scientific and Cultural Organization, Paris, 2014, p. 12. <https://sustainable-development.un.org/index.php?page=view&type=400&nr=1674&enu=35>



## Using the Internet as a tool

Today, more than ever, in light of increasing digitalization and in view of young people's often-lamented uncritical consumption of digital media and social networks, the Student Repair Shop's inclusion of the Internet is especially important. Because in this context, the Internet is not used for entertainment but as a tool, a resource that is utilized when students look for help on YouTube or blogs, visit manufacturers' websites, order spare parts or seek further information on repair-network websites. This allows them to experience the medium as a tool and not based on their own interests, but on pertinent questions in connection with their repairs. Since teenage Waldorf students are less likely to use the Internet's entertainment offerings regularly, it is particularly important that their first intensive encounters with this medium come under the heading of "work", as this can counteract casual, unthinking Internet use.

## Transfer of content from other subjects

Repairing electrical and electronic equipment, in particular, offers a wide range of opportunities to focus on school content using practical examples. This especially holds true for topics from the fields of physics, technology and mechanics. This transfer is particularly valuable from an educational point of view because it takes place exactly during the time when students have questions relevant to these areas, and they can experience the practical implementation of the theoretical context for themselves. They follow teachers' and repair instructors' explanations with great interest. Particularly complex issues are illustrated on a blackboard.

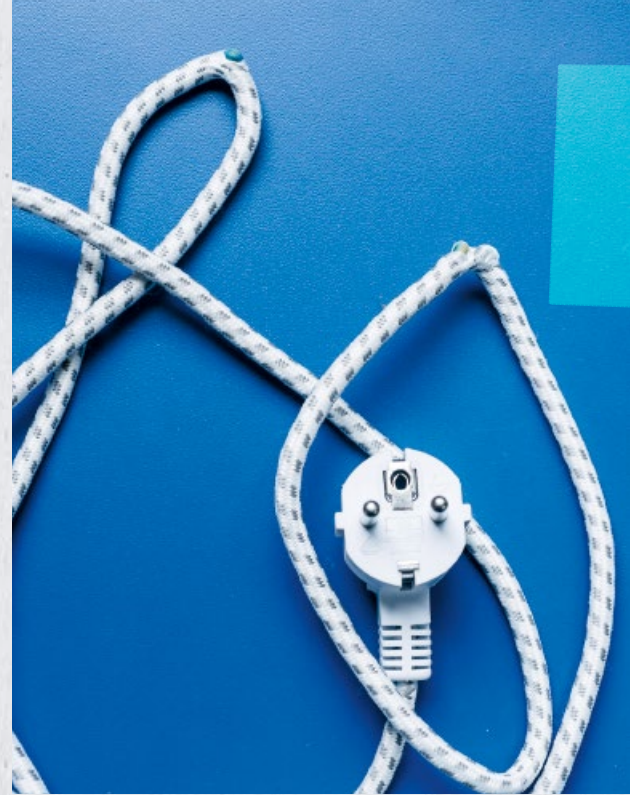
## Differentiated perception and a "feel" for things

If we look at the educational outcomes of the Student Repair Shop that are even more strongly demanding of the students' personal abilities, one of the first thing that stands out is the level of perception involved: precise sensory perception is important for repair work, especially perception involving the senses of sight, hearing, touch and smell. This already begins with the first customer interview, where it is important to listen carefully to what the customer describes and to ask questions if something seems unclear. Next, refined sensory perception is required when troubleshooting the device to be repaired. This step shows that visual perception initially dominates among students.

Gradually, however, they learn to make greater use of other senses as well. In particular, students placing increasing emphasis on acoustic perceptions (what clues do sounds from equipment and tools provide?) as well as on perceptions of touch (what is the surface of a part like?) and on perceptions of smell were observed. Conspicuous traces on capacitors can be identified as scorching, for example, by using the senses of sight, touch and smell.

In addition to good perceptual skills, work in the Student Repair Shop requires **physical coordination and fine motor skills**. Most of the time, repairs inside the device involve dealing with tiny parts in a confined space. Fine motor skills are also required when handling many common tools, for example when soldering or when removing and inserting tiny screws. As far as this is concerned, a general increase in body control could be observed over the course of the observations. Students' improved physical understanding of their own bodies can also be deduced from further observations: Whereas students' excessive energy initially leads to them repeatedly bumping into furnishings and equipment, over time they learn to move more calmly and purposefully.

This development is also associated with the formation of a feel for the work and for the handling of tools. Improved dexterity, a developing attentiveness and increased comfort with and acceptance of procedures were also observed.



## Learning what (really) matters

In addition to the educational outcomes already mentioned, there is the pedagogically significant learning outcome of **"learning from the object itself"**. If students are on the wrong track, or if they based their approach on false assumptions, the Student Repair Shop's discovery and experience-driven work and learning methodology allows them to directly experience the object's "response" to their actions. Unlike in school, for example, there is no external authority judging students' work; it is the students themselves who find out what went wrong – and, of course, what went right. This conveys a vital understanding of what is important for repair work, and further, it develops the basis for a competence that can be generalized and one that will benefit them in their private and later professional lives – far beyond their activities in the Student Repair Shop. And, through their own experience, they learn to **think and act in a manner appropriate to the task**.

With regard to the student's own handling of the repair tasks (Did I misjudge something? Where was I too impatient? Where could I have been more concentrated on my work?), the **"learning-from-the-object-itself"** learning outcome is at least as important. Teachers and volunteer repair instructors support the students in this process of self-reflection that is so central to the young people's development of the ability to judge things for themselves and evaluate themselves realistically, and which therefore contributes to the development of their personalities.

"We found out over time that certain appliances have certain typical problems, for example the water supply on coffee machines or the power cords on irons"

(Student, 9th grade)

## Personality development

In general, either directly or indirectly, the work in the Student Repair Shop is intended to support students' personality development. The learning outcomes already described are part of this goal. Beyond these, however, a number of further aspects were also observed, which we would particularly like to emphasize here. Especially during adolescence, in order for a person to think and act effectively, it is important to have fields of learning and experience available. The core challenges of this phase lie in developing a new, independent relationship to oneself, to others and to the world in general with all its phenomena and constructions. Because it demands and encourages concentration on something outside oneself, working in the Student Repair Shop helps young people to get a better grip on their own, often unbalanced, emotions (a broken massage device, which especially among male students initially triggered a variety of comments, provides a good example of this).

Students who are quick to get enthusiastic about things, only to lose focus just as quickly, learn to keep at it. Students who find it difficult to get going are motivated to participate by the "pull" effect that this interesting work has. All students experience that mistakes can occur without these mistakes leading to the failure of the repair process – and that it is important to learn to "read" the mistake, to draw conclusions from it and to take a different approach. This means that it becomes clear to these young people that success, in dealing with difficulties and in learning a lot in the process, is in their own hands. The encounter with

the objectivity of the situation – the repair and its requirements – helps students to gain insight into the connections between the requirements of the thing and their own procedure, and thus supports a kind of self-knowledge and realistic self-assessment that goes beyond simple over- or underestimation. The fact that working in the Student Repair Shop is not a competitive or performance situation, unlike in sports, for example, also helps.

Personal skills such as independence, the ability to concentrate and persevere, and the courage to take on the unknown are also promoted. The ability to connect with a thing, stay focused on it and then to disengage from it when it's done, is also supported to a significant degree. This is a challenge for the students, a fact that can regularly be observed at the end of a repair class: students are often so engrossed in their work that they ignore the announcement that the class is coming to an end and that they should now start cleaning up.

Having a say in the level of difficulty of the work they undertake also has an effect on students' personal development. Situations arise time and again in which two-student teams will ask to be allowed to take on a more difficult repair because they have the impression that they have already mastered "standard repairs".

## Willingness training and working for others

Another educational outcome was also observed: the work in the Student Repair Shop is connected with an eminent training of willingness. By working on things for real customers, and, through the initial customer interviews, by gaining the insight that these people are handing their cherished objects over and trusting that they will be properly treated and repaired, the work takes on the character of seriousness and commitment to the highest possible degree.

This makes it easier for the teams to achieve an attitude of “what is – not what is pleasing” (Goethe). In other words: instead of their own desire or unwillingness to do a thing, students are guided by a goal that serves the object itself, and that goal lies outside their own personal goals. They can only achieve this goal if they consciously identify with it and consciously decide to make it “their thing”.

One student expresses this succinctly: “You have to want to repair it! That isn’t something you can impose on someone; you can’t force anyone to do that”. During adolescence, when the back-and-forth of different moods is such an issue, working in the Student Repair Shop is especially helpful in moving young people’s focus away from themselves and in putting them selflessly at the service of others. Again and again, students can be observed motivating themselves: “I don’t really feel like it right now, but the repair has to be finished, the customer needs their device”.

In order to achieve this motivation, it is important that the reward for this effort – both of the will and the physical effort – come exclusively from the thing (the repair) and from the pleasure of giving to others, and not through financial or other incentives. The Student Repair Shop’s concept of offering repairs for free gives students a wide range of opportunities to experience this. It thus not only helps students “get through adolescence” – which was a central concern of the teachers’ initiative – the experience that the satisfaction of working for others goes far deeper than the short-term fulfillment of personal desires also helps develop intrinsic motivation.<sup>17</sup> This also makes scenarios like the following possible:

A team had tried to repair a coffee machine. Because the students suspect that the problem may have something to do with blockage due to limescale buildup, they take the machine apart. They then realize, however, that their hunch was wrong and that there must be another problem. Frustrated, one of the students says, “now all the work we did was for nothing!” The other student, however, responded with “No, we had to do it anyway, in order to know what we now know”.

<sup>17</sup> This is a technical term used in the psychology of motivation and learning. “Intrinsic motivation stems from the experience of the behavior itself or the expectation of that behavior”. (translated from Deci & Ryan, 2000). That means that the relationship to the object of learning motivates the learner without external incentives (rewards or punishments). “Reward is instead provided by (bodily) cognitive and affective processes. High intrinsic motivation often forms a prerequisite for creative performance. Many studies prove that intrinsic motivation is superior to extrinsic motivation. According to a six-year study at the University of Munich, intrinsic motivation is even more important for learning success than intelligence”. Translation of a quote in: [lexikon.stangl.eu/1949/intrinsische-motivation/](http://lexikon.stangl.eu/1949/intrinsische-motivation/)

## Social learning

The Student Repair Shop also offers a broad field of opportunity for social learning. Students work in two-person teams, which means they have to agree on which person will take over which tasks, and they have to be able to recognize when their partner cannot manage without their support, even if they themselves may be occupied with other tasks. Such requirements are by no means easy to fulfill; both team members need to be able to perceive and comprehend their partner’s abilities, which they can only achieve if both team members are fully engaged in the task at hand. They often consult with each other on how best to approach the next step of a repair. They do not always agree, but learn to proceed in accordance with the more convincing argument. Students also learn to offer constructive criticism of their partner’s approach (“I think it might be better if you cleaned the gears before you glued them”). They also motivate each other when progress slows – “What we need now is optimism and patience!” As a whole group, students also have to come to consensus when, for example, a lot of new repairs have been brought in and the allocation of these repairs to the various teams needs to be clarified.



This teamwork usually takes place without friction. On the one hand, this is probably due to the conditioning that students receive through the Waldorf school's many activities that students do together. On the other hand, at least part of the social learning outcome is certainly due to the real challenges that students have to deal with in the Student Repair Shop, which they would not be able to master by themselves at all. Therefore, it is not at all difficult for students to take over a repair that another team has already been working on. Students supporting other teams was also observed. The challenge of succeeding at something that others have failed at so far often plays a role; for example, a student says: "You weren't able to repair that yesterday, so let's trade... We'd like to give it a try!"

Students are also able to explore opportunities that might offer support for aspects of a repair which are beyond the scope of the Student Repair Shop. For example, they might get in touch with the school's blacksmith group when a broken metal part needs to be welded.

Social learning in the Student Repair Shop, is supported by the fact that the two-person teams are joined by a "third member of the team" – the object to be repaired. This special constellation should not be underestimated, because it makes it possible to meet in a space where each student depends on each other and each other's productive cooperation, regardless of personal friendships or even antipathies.

Research on cooperation and communication has shown how effective a joint connection to a third party can be; experts refer to this as "object-mediated cooperation and communication". It has been shown that both the partners' cooperation and their accompanying communication intensify significantly, and that these both become more specific and produce better results when facts, planning, coordination, etc. take place when the object in question is directly (physically) involved.

The contact with the numerous customers who visit the repair shop is another important opportunity for social learning. Although some students were initially rather inhibited during these first interviews – which could be seen, for example, in the fact that they only recorded the results of the conversation on the docket after it was over, or in the fact that they were embarrassed by the question about the "customer's relationship to the item to be repaired" – their confidence in dealing with customers quickly grows. The young people become more involved in these conversations, even to a point at which a student will console a customer: "Don't worry, we've had much worse!"

The cooperation with the mostly much older volunteer repair instructors is another important area for social learning. Here, older and younger people encounter and have to show understanding for each other. Even on their very first day of work in the Student Repair Shop, students are surprisingly at ease with these older people who, at least initially, they usually do not know. As agreed, everybody addresses each other by their first names (translator's note: in Germany, young people will usually address people who are obviously older than they are more formally, using Ms. or Mr. plus the person's family name). The tone of the communication that can then be observed throughout is, in a sense, collegial: these people are working together and communication takes place almost exclusively about the common objective of the task at hand. The teams recognize and acknowledge the volunteers' professional authority without being intimidated by it. The volunteers, in turn, are open to students' ideas and emphasize time and again that they themselves learn a lot from working on these repairs together with students. Thus, the Student Repair Shop offers an excellent opportunity for intergenerational learning and for work-based encounters between different age groups.

In summary, it can be said that the Student Repair Shop offers a very wide range of educational outcomes. And, in addition to all the points mentioned, students acquire a great deal of experiential knowledge and develop competencies that they already have.

# What do students think of the Student Repair Shop?

During a group discussion, students from all grades commented on their experiences of working in the Student Repair Shop. All of them were grateful for this opportunity and reported effects that the Shop had had on their lives outside of school.

Some noted examples:

*"You just need that for life!"*  
(Student, 10th grade)

*"For me, the most important experience in the Student Repair Shop was how difficult it is to open the devices. You realize that the manufacturers don't want you to do it. And when you finally do get it open, there are only wires in it!"*  
(Student, 6th grade)

*"At home, sometimes you don't have enough time to fix things, here you finally have time to do it".*  
(Student, 10th grade)

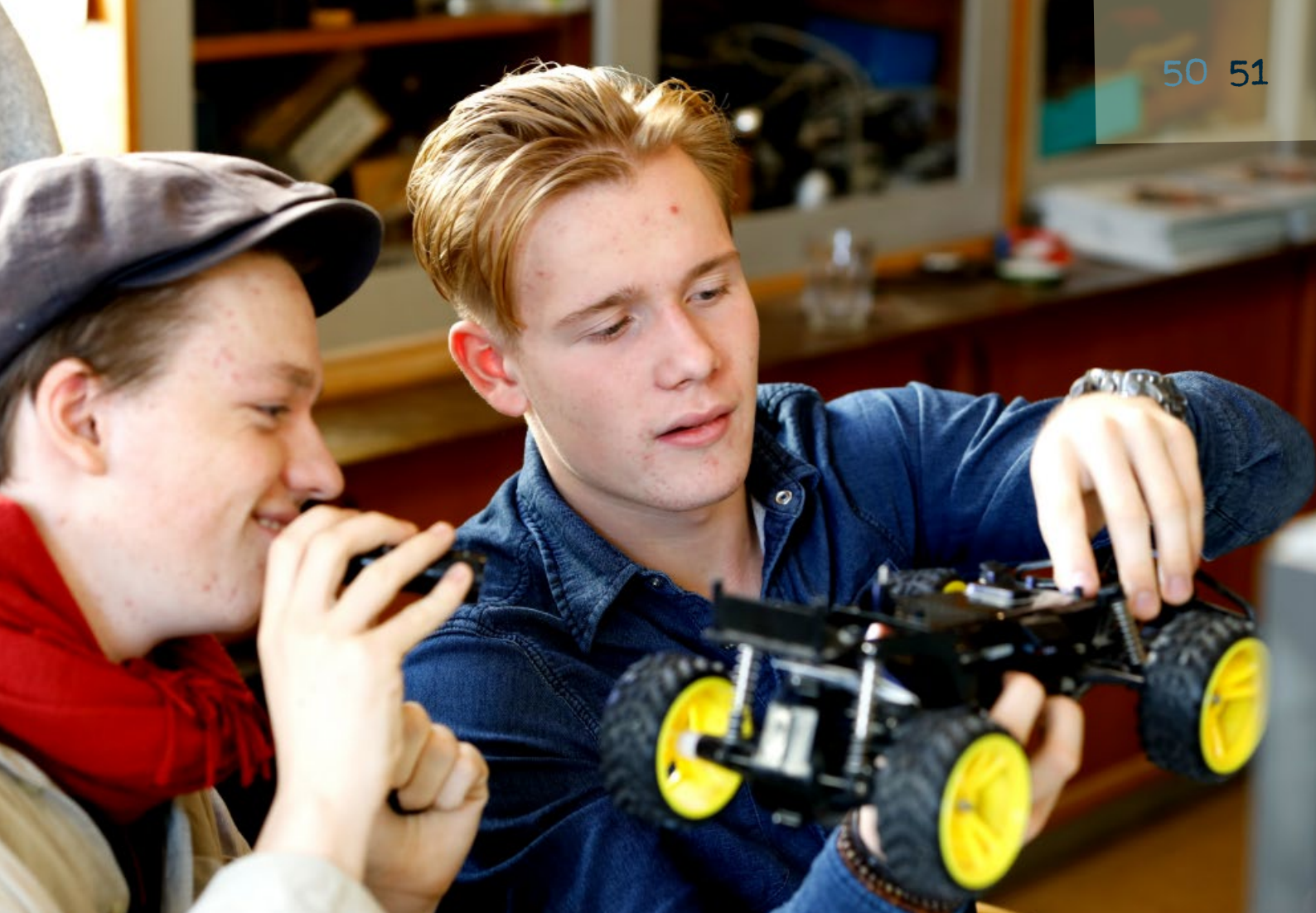
*"Where the customers are concerned, I sometimes find it sad that sometimes all we have to do is change a light bulb, then the device works again. So you can see how important a course like the Student Repair Shop is!"*

(Student, 10th grade)

*"We found out over time that certain appliances have certain typical problems, for example the water supply on coffee machines or the power cords on irons".*

(Student, 9th grade)





*"I definitely repair things a lot more at home now".*  
(remark made by almost all students at all grade levels).

*"I was already interested in repairing things, and before the Student Repair Shop, I used to open appliances up. But before, I didn't dare to close them again. That's different now".*  
(Student, 10th grade)"

*I understand that customers care about their stuff – I don't throw away my old dolls either".*  
(Student, 10th grade)

*"I had a sense of accomplishment on my first day in the Student Repair Shop, it made me all enthusiastic! I had never soldered before, and I figured out how to do it. You can connect wires so easily by soldering them!"*  
(Student, 10th grade)

*"Handing the repaired device back to the customer was a highlight".*  
(Student, 10th grade)

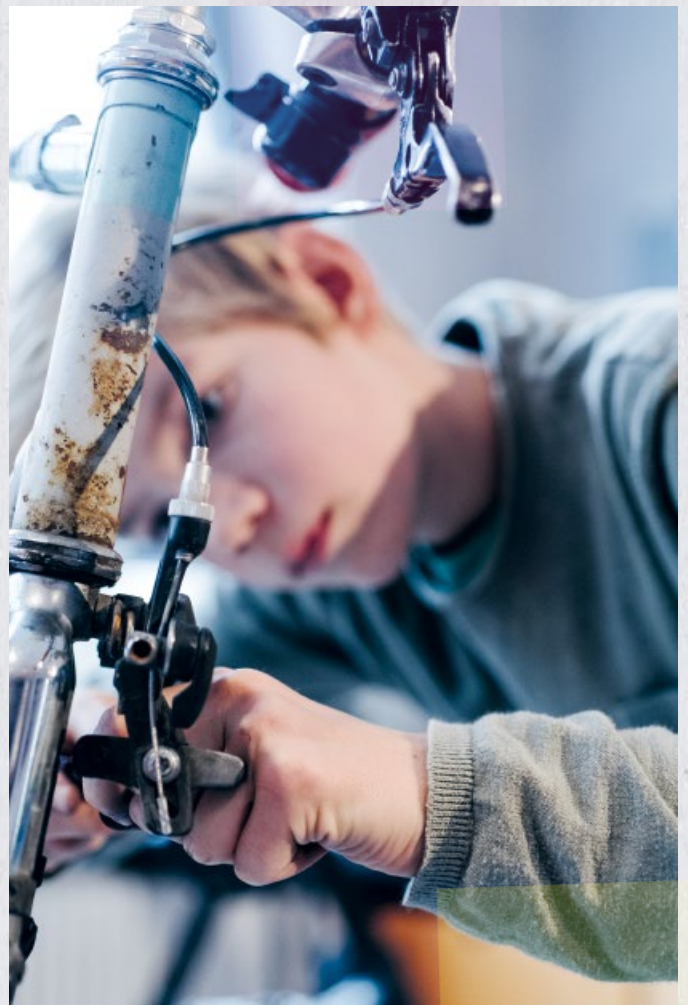
*"Since I couldn't be there the first time, I thought the others could do much more than me. Even though I have always repaired things at home, a sewing machine, for example, which was very important to my mother. I've always been curious about repairing things, but I never had the courage to open things up. I am not afraid to do that anymore".*  
(Student, 10th grade)

"My daughter now has the confidence to tackle things that even I would be hesitant to do - things I would need to read the instruction manual three times for".

What do parents think about the Student Repair Shop?

Our scientific advisor collected parents' points of view through an intensive group discussion and through telephone interviews.

First of all, it is striking that all the parents interviewed unanimously welcome the Student Repair Shop as a useful class. For example, they call it "an extremely useful initiative" or say "this is a great project that I fully support" or "the organization of the Student Repair Shop is super, I am overwhelmed by what this teacher manages to do". Furthermore, all respondents feel very well-informed from the outset and emphasize this transparency with enthusiasm. They particularly appreciate the Student Repair Shop's educational outcomes.



"I definitely repair things a lot more at home now".  
(remark made by almost all students at all grade levels)

The following conversation with the mother of a sixth-grader provides a typical example:

*My son is an explorer who likes to take things apart. The fact that you can fix things fascinates him. He's interested in how things relate to each other. As soon as he heard about the Student Repair Shop, he immediately brought a broken lamp there.*

*It's also important for him to know what tools are available, how the workshop is set up, and how to put things in order when you've taken something apart. He has built a tool-wall like this in his room, too. At first, he didn't talk that much about the Student Repair Shop at home, but now he likes to talk about it in detail at meals, about batteries, for example, or about working with the volunteer repair instructors.*

*He also helps a lot around the house. He repaired his sister's cell phone, for example. And he had been wanting a scroll saw for a long time. Then, together with a volunteer, he repaired one from the school workshop that was broken – it had been lying around there for two years.*

*From an educational point of view, the Student Repair Shop 'sorts my son out', and I think that that is really important. He himself says that he is quick to be enthusiastic about something, but that his enthusiasm also quickly fades. In the Student Repair Shop, he learns to stick with it. I can then continue to support him at home. He is also learning to do things more systematically and gaining insight into how things are constructed – and he is picking up a lot of technical know-how. Working in the Student Repair Shop gives him confidence; he is getting a lot of affirmation and developing this incredible independence. The work is very appealing to him; he feels at home in the Student Repair Shop.*

*I am glad that they offer this course, so that at his age, my son is not in danger of being bored. I think the whole thing keeps him going. In the meantime, he even takes the initiative to ask the school janitor if there are any repairs he can help with".*

Other parents report similar experiences. A father of a 10th-grader, for example, talks about the repairs his daughter has already made. He would, however, like to hear more from her in general. But she – like many other students – does not talk very much about herself. It was important for her, however, to report how amazed she was at how relatively easy it is to repair things that commonly break down. She hardly mentioned the cooperation with the volunteers.

The father of another tenth-grader says that his daughter had already shown an interest in working with her hands before she started working in the Student Repair Shop. That has now intensified considerably. "My daughter now has the confidence to tackle things that even I would be hesitant to do – things I would need to read the instruction manual three times for".

A seventh-grader's mother also highlights the fact that, in the Student Repair Shop, her son "is finally learning not only to take things apart, but also to put them back together again". Her son particularly enjoys working with people who are just as interested as he is. She draws attention to another important aspect: Her son is not interested in sports at all – "through the Student Repair Shop, he is finally getting some recognition". Other parents also mentioned the same thing with regard to their children.

Another seventh grader, according to his mother, "as a three-year-old, just went ahead and fixed a doorknob". When he heard about the Student Repair Shop, it was immediately clear to him that he wanted to participate. For his mother, it's especially "great that his desire to take things apart and repair them is now being channeled. I have noticed that my son is more interested in the actual process of repairing things, more than about using whatever it is that has been repaired".

Like other parents, for this mother it is important that the Student Repair Shop promotes "handling things with care and appreciation". In order to try to repair them, her son now collects broken devices from family and friends.

Conventional “Shop” and Sewing classes lay an important foundation for students’ personal development as well as for their repair skills. The Student Repair Shop, however, goes beyond this: “In the Student Repair Shop, the students experience meaningful work. They realize that seriousness is required here, which ‘grounds’ them”, says one mother. She means that the real repair orders in the Student Repair Shop bring students closer to the conditions of the outside world and thus have a different motivating effect than “only” lessons would, i.e. it is “just like real life”.

It is also important to parents that their children get to experience networking with modern technologies (e.g. with the 3D printer) in the Student Repair Shop. The “working” use of PCs and the Internet receives a lot of positive emphasis and also has an impact on students at home. Students who do not yet have their own access to a computer at home, will now ask their parents for permission to do research on the Internet.

The mother of another seventh-grader notes that the Student Repair Shop helps her very-active son to focus on goals, and that it also channels his tendency to overestimate himself. “I think it’s good that the students don’t work toward ‘nothing’ as they do with homework, for example, but that it’s about a real result and the work has meaning. This motivates kids to work differently”.

Parents unanimously report that their children have gained self-confidence through their experience in the Student Repair Shop. “My son’s twin is amazed at what his brother has already learned and now has the confidence to do”. According to parents, it is also important that students do not experience competitive pressure to perform in the Student Repair Shop, as they do in sports, for example, but “that you can just be who you are”. They often underscore the importance of the experience that making mistakes is normal and that the students don’t have to take mistakes personally, but can actually learn from them. Parents also appreciate the connections that are made with other school subjects, e.g. physics, and assume that such content will be easier to understand as a result.



Last but not least, their work in the Student Repair Shop leads students to bring their increased environmental awareness to bear at home as well. Parents often report of their children discouraging them from throwing things away that no longer work – “you can fix that!” This is very well-received: “As parents, we feel that it's good to be doing something to counteract our throwaway society”.

“I understand that customers care about their stuff – I don't throw away my old dolls either”.

(Student, 10th grade)



# "You've really accomplished something!"

## Feedback from customers

Whether they found the Repair Shop through the school environment or in some other way, without exception, the Student Repair Shop's customers are unanimously enthusiastic about the idea, and about the actual work that the students do. There are several facets to this positive assessment.

## The Student Repair Shop encourages sustainable behavior

The concept of bringing children and young people into contact with the idea of repair is particularly well received. Many believe that it is especially important for young people to learn how to offset the tendency to automatically buy new things and for them to acquire the skills and abilities necessary to do so. When they bring things to the Student Repair Shop, customers not only want to have their devices repaired, they also expressly want to support the initiative ("Great idea, very important!"). One customer feels that the Student Repair Shop is "the best way to motivate young people to live in an environmentally conscious manner. Through the Student Repair Shop, they comprehend how important it is to keep the things that we already have usable. So these students are also dealing with the question of how we want to shape our future".

## People are enthusiastic about the idea of repairing things

In many conversations, customers have mentioned how important the idea of "repairing things instead of throwing them away" is to them. On the one hand, this has to do with the salience of environmental protection and sustainability in general. On the other hand, however, it becomes clear that repairing things is also a highly emotional topic: The people interviewed immediately tell their own repair stories, or mention how they were influenced by their parents and grandparents who repaired things, and their eyes light up when they are talking about these loved ones.



## "I'm very attached to it"

A particularly large number of repairs come in through repair networks; contact is first made via email, and the customers then come by in person.

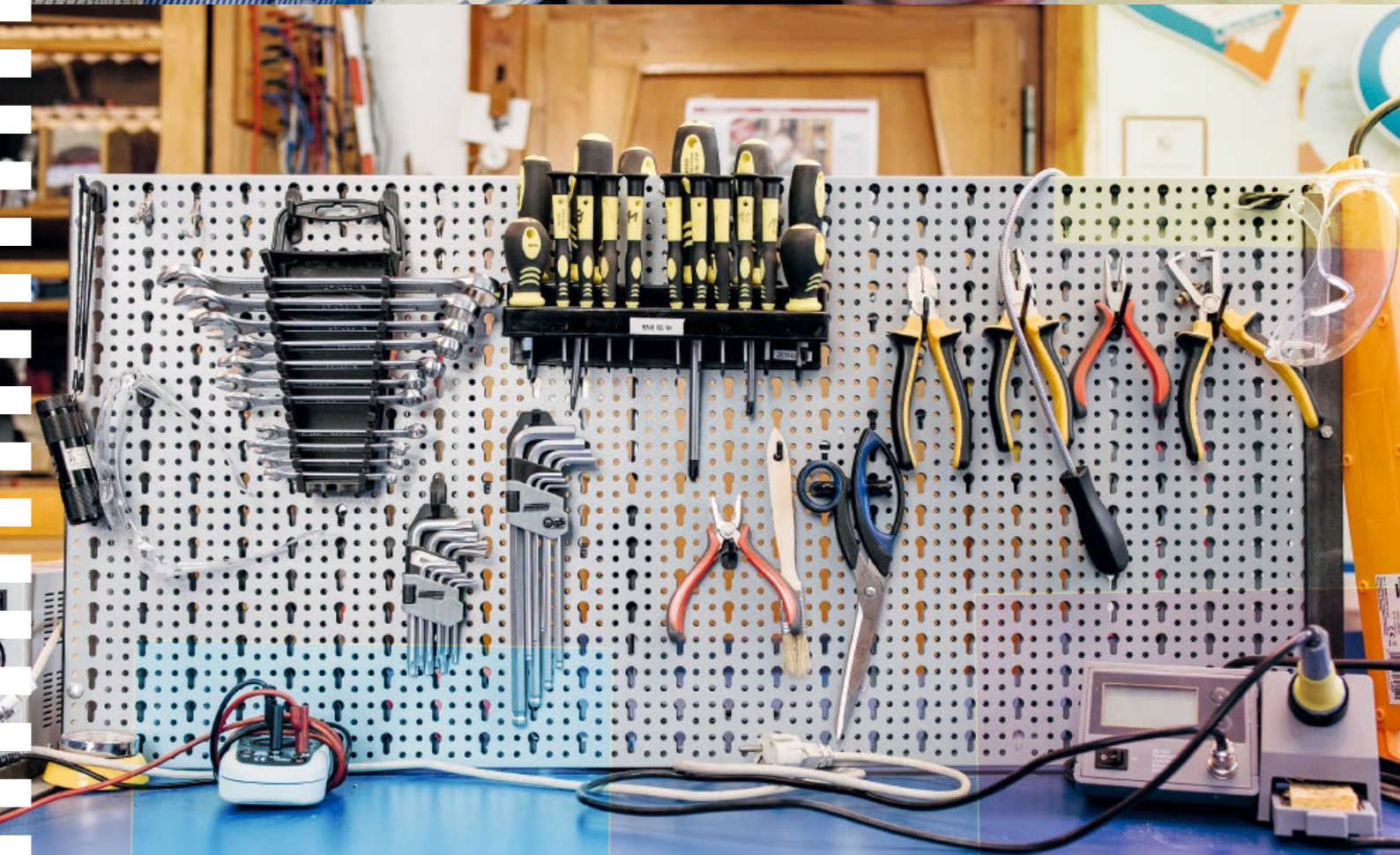
But there are other ways of spreading the word as well. For example, an article in the German journal for Waldorf education "Erziehungskunst" ("The Art of Education") led to the following email inquiry from a customer in Freiburg, a four-hour drive away from Munich (excerpt shortened):

*"I read about your project in 'Erziehungskunst', and I think it is really super! I have a polite request: I own a fan-driven heater that is over 50 years old and which stopped working a few weeks ago. I am very attached to it, as my mother used it to keep me warm after bathing me when I was a baby. Would you be willing to try to repair it? The unit is all metal, and I can't see any evidence of asbestos. The motor still turns, but very slowly, which could be due to the carbon brushes".*

After the Student Repair Shop agreed to take the job, the device was sent in by mail and was successfully repaired with the help of an old component. In his thank-you letter, the happy customer made a "confession":

*"Before I contacted you, I had asked a colleague of mine who studied electrical engineering if he could help me out, but he did not think he would be able to make the repair. So you've really accomplished something! And you even cleaned and polished the heater so that it shines!"*

In spite of such positive experiences, however, the students also have to realize that some customers bring things in which are indeed broken, but which don't really urgently need to be repaired. Some people apparently want to "give the Student Repair Shop something to do", which, in view of the large number of repairs that really are needed, is unfortunate. Others presumably try to soothe their own conscience by handing their broken equipment over to the students, simply so that they do not have to throw it away themselves.



# Part III: Practical implementation

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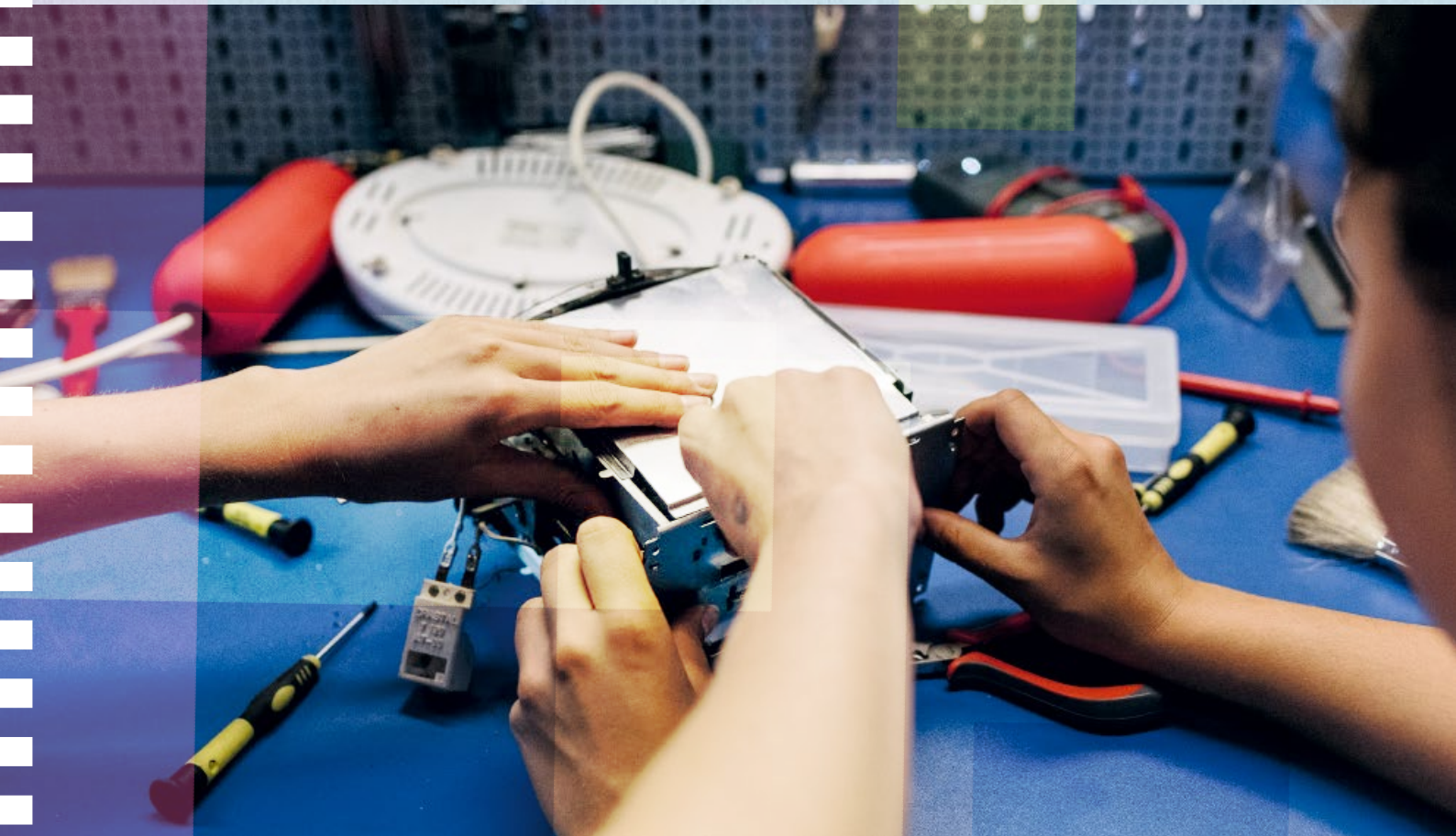
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# Suggestions for organizing a Student Repair Shop

In this section, we describe the spatial, material and personnel requirements for setting up a Student repair shop. In so doing, we describe our experiences, which are only intended serve as a guide for those who would like to create a similar facility at their school. Presumably, the conditions at each school are different, so the guidelines here must be adapted accordingly. We believe that taking a process-oriented approach to setting up a Student Repair Shop and that determining subsequent steps based on your own individual situation and experience is a good idea. For example, it was not clear to us from the outset that customers would mainly be bringing electronic devices and electric appliances in to be repaired. As a result, we ended up equipping our workshop one step at a time.

## *How did it all begin?*

The Student Repair Shop began as an elective for the 9th and 10th grades, as a 12-week course with three double-class periods per week. The following school year, we also offered the Student Repair Shop in grades six and seven of our all-day school. For the sixth and seventh graders, participation is voluntary. This is a continuous course over the entire school year with a double lesson one afternoon per week.

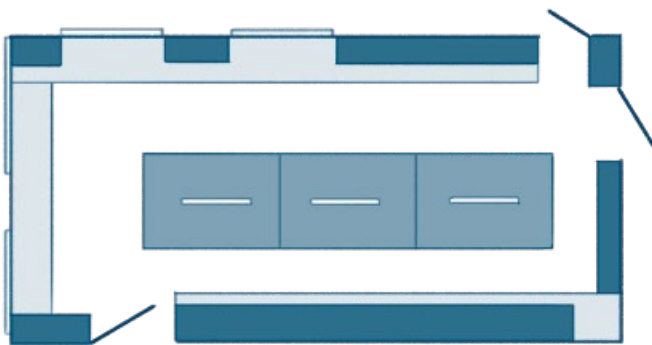
In today's world, it is essential to have a working knowledge of widespread technologies and to understand them. In addition, technology per se is to be understood as a process that is inseparable from the human beings who use and produce it, and that, accordingly, there are scientific, engineering, ecological, psychological, economic and sociological perspectives to understanding it as a phenomenon. Waldorf schools have therefore introduced technology classes, and some public schools in Germany have the subject "Man and Technology".

With this in mind, we decided to offer the Student Repair Shop as the required technology subject for the 11th grade. In Technology, alternating groups of twelve 11th-grade students repair things during a four-period block, one day a week. This class is mandatory for all students.

## Things that needed to be clarified in advance

In order for it to be approved and subsequently communicated to parents and the student body, the concept and educational goals of The Student Repair Shop first had to be presented at a school conference. We would be happy to provide the PowerPoint presentation that we used at the conference as a template for anyone who is interested. An appropriate general framework for the shop also had to be created in advance; suitable rooms had to be allocated, for example.

The school's cleaning staff should also be informed about the repair shop. We had a case where a cleaning person disposed of a chair that was being repaired because she thought it was so broken that it had to be thrown away.



## Space and equipment required

Having a separate room for the shop would be ideal. We set up a workshop for repairing bicycles and electric appliances in our physics room. Wooden objects are repaired in our wood shop.

The space you will need really depends on the size of the class that you will have. Each student should have two square meters (21.5 square feet) of space to work. Each two-student team will need a workstation with a wooden work surface at least 140 cm (55.1 inches) wide and 60 cm (23.6 inches) deep. The workstation should have enough space to accommodate items to be repaired, measuring instruments, a soldering station and power supply units, and it should also have space where a small vise can be mounted. To ensure easy access, tools should be hung on a perforated wall-board installed near the table. Portable steel cabinets with lots of small drawers are practical for keeping spare parts and other small items within easy reach.

It would also be good to have a separate test station where students can perform initial tests on devices before opening them up. This test station can then also be used by the volunteer repair instructors to test open devices with the power on. Functional and safety tests should also be performed, together with students, at this measuring station before repaired devices are returned to customers. So, as a safety precaution, devices are only connected to power at this test station and never at the student workstations.

Good lighting is important. Bright room lighting and additional table lamps are helpful for being able to see what is going on with the objects to be repaired. Magnifying lamps with powerful LEDs and a large magnifying glass mounted on an adjustable swing arm are also useful.

Every student repair shop should also have at least two computers or laptops connected to the Internet. These are indispensable for doing research on how to open difficult devices, for example, for accessing helpful troubleshooting information on repair blogs and for ordering replacement parts.

## *Financial / funding requirements*

We started with a grant of 1,000 euros to buy tools for five two-student workstations (four for electrical repairs, one for bicycle repairs, and we asked parents to donate any tools and screws that they no longer needed. The mobile workstation that we use for repairs in or on the school building is also equipped with some of these tools. At a later stage, we set up two more workstations for electrical repairs and acquired several 3D printers to produce parts which are no longer available.

For storing items to be repaired, and those already repaired, it is a good idea to have as much shelving as possible mounted on the walls. Partially disassembled devices, containers of removed screws and receipt of order forms can be put into storage boxes that fit on these shelves, making it easy to clean workstations up when class is over. This is especially important if the workstation is going to be used by other students. If workstations are grouped along the walls, there is usually no need to run power cables across walkways or between stations. If cables do have to be run along the floor etc., heavy-duty traffic-proof extension cords and cable bridges will be needed. The following general principles should always be observed:

- **Keep walkways and emergency exits clear**
- **Use stable furniture, fixtures and other infrastructure**
- **Avoid trip hazards, recognize and eliminate sources of danger**
- **Keep fire extinguishers and first-aid kits at hand and readily available**

## *Time requirements*

Since it can often take a long time just to get a device open, our experience has shown that double lessons (90 minutes, total) are indispensable. Locating the source of a problem, ordering parts, cleaning up workstations and taking notes on what has been learned all take time.

## *Personnel requirements*

It is absolutely necessary that a teacher always be present in the Student Repair Shop to supervise work in progress. And, you will also need volunteer repair instructors to accompany student teams and provide additional advice. In addition, (at least by German law) a qualified electrician has to be available. By qualified, we mean an electrician who has successfully completed professional training, e.g. as an electrical engineer, an electrical technician or a master- or journeyman electrician. Professional certification can also be achieved through several years of both theoretical and practical training and examination by an appropriate authority. If a certified electrician is not otherwise available, you can arrange to receive qualification as a repair instructor, or alternatively, through the school community, through local trade guilds or through one of many repair networks, you may be able to find a qualified electrician to come in regularly to test repaired devices with the students.

# What about volunteer repair instructors?

To a large extent, the Student Repair Shop's success is going to depend on recruiting a sufficient number of suitable volunteer repair instructors. We advise advertising for volunteers in the school's immediate vicinity.

Our experience has shown that it is best for one volunteer to support four to six students, so you will need a corresponding number of volunteers. As mentioned earlier, a teacher should always be present in the room to supervise work in progress.

## *Some pointers for recruiting volunteer repair instructors*

- Volunteer instructors should have sufficient qualified professional experience
- Choose enough volunteers from different disciplines (electrical/electronics, woodworking, etc.) to cover the types of repairs expected
- It is particularly important that volunteers are available as regularly and as long-term as possible. The extent to which they can commit themselves, whether they prefer certain days, etc. should therefore be clarified with them in advance.
- As early as possible, ideally during their initial interview, volunteer repair instructors should be informed about the Student Repair Shop concept, especially about the methodology of discovery and experience-guided work and learning.
- Accordingly, volunteers should be prepared to use their own expertise for the students' learning benefit. This means using their expertise with restraint or applying it "in passing". The volunteer repair instructors' motto should be "No teaching, no instruction!"
- Volunteers' enjoyment of working with young people will benefit the volunteers, and it will benefit the students!
- Good observation skills and the ability to recognize when support is needed and when it is better to wait and see if the students can make progress on their own are also helpful.
- Patience and composure are important when dealing with young people.
- Last but not least, volunteers should be willing to participate in opening and in reflection sessions.



## Dealing with impasses, lack of motivation and inappropriate behavior

Although students are very eager to get started, the work process can get bogged down if repairs take a long time. Here, volunteers can help with gentle suggestions, preferably in the form of open questions.

*A student is sitting helplessly in front of a power strip that no longer works. She can't find the cause of the problem and seems discouraged. A volunteer sits down with her and patiently asks: "What have you tried already? Where should the power be coming from? What can you touch and what can't you touch? Why?" The student asks the volunteer to tell her about alternating current in more detail. The volunteer does, the student is able to mentally grasp the problem, and she then has an idea of how to approach the repair.*

Questions about what exactly the problem is or what a device should be doing can help with troubleshooting. A little background information, from the sidelines and only as necessary, may help a student to more easily understand the interrelationships relevant to the repair at hand. Helping students to distinguish between repair-friendly, difficult to repair, and downright "cheap" devices can provide insight into manufacturing costs and safety considerations (protective insulation, child safety features, etc.).

Asking questions can help, but in cases where students lose motivation due to frustrating repair attempts, volunteer repair instructors may also choose to encourage students and bolster their confidence in finding a solution. Small hints at things that could be tried can help students to find their own way of solving the problem. If the instructor is not sure about what the problem is either, they can "think out loud", i.e. share their thoughts with the student – perhaps they can then come up with an idea together.

*"The learning outcome that we are hoping for, after all, is supposed to be that even seasoned professionals rely on the same ordinary everyday methods, and that trial and error is not a bad thing."*

Initially, many of the tools, materials and techniques in the Student Repair Shop will be new to most students. This can lead to students "playing around" with them at first. Here, the volunteer repair instructors can skillfully direct the students' interest back to the matter at hand.

*A student is playing around with some solder. The volunteer says, "I don't want you messing around with that. Would you like to try soldering for real?" The student enthusiastically agrees.*

Volunteers can also make it clear that the proper use of tools and materials also helps the Student Repair Shop to conserve resources.



## Guidance, but with restraint

In our experience, the greatest challenge for volunteer repair instructors lies not with answering technical questions, but with exercising restraint and being open to students' creative ideas:

*"It is amazing to me how little fear of contact the students have when opening equipment. I had to pull myself together a bit in order not to intervene".*

*"In my case, I see that there is a danger of me of wanting to explain too much."*

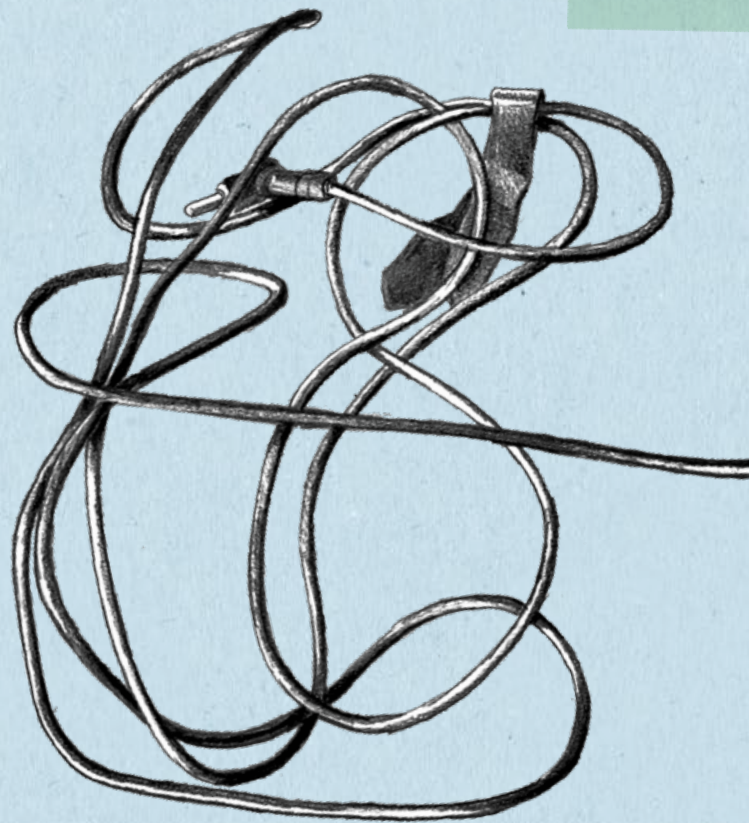
## How the volunteers themselves see their work

Volunteering in the Student Repair Shop not only benefits students and teachers - the volunteers also appreciate the work that they do:

*"For me, this work is totally exciting, I enjoy it. I learn a lot myself, too, for example, when I watch repairs that are not within my area of expertise."*

When made "redundant" by a student's initiative, volunteer repair instructors are pleased:

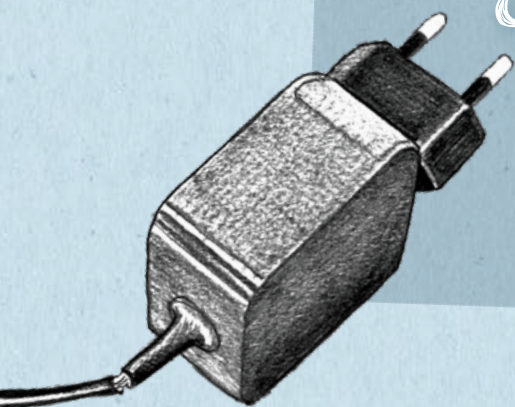
*"The repair instructor is both an attentive observer and a kind of "patience generator": The instructor needs patience for the students, who are put to the test by looking for the source of the problem, or by 'How does this thing open? But the instructor also has to be patient themselves, as they have to restrain themselves from helping too much. This restraint, however, is also rewarded, as the following experience illustrates: J. and A. are both in the 7th grade, but what complete opposites! J. is quick to see what the problem is; he concentrates on his task and is aware of what is going on around him, without being distracted. A. is attentive and understands things quickly, but his interest remains rather superficial because he likes to know about everything that is going on in the room, and he doesn't refrain from paying attention to whatever that is. Immersing himself in a task is not really his thing. So now he is faced with a problem with a repair and he's stuck. J. sees this and turns to A.: 'Let me explain it to you'. A.'s classmate takes on the role of repair instructor."*



## Criteria for accepting items to be repaired

The work performed by the Student Repair Shop is an **attempted** repair, and no guarantee of success can be given. In general, the following applies: the suitability of any given repair for the Student Repair Shop depends on the condition the object is in. Electronic devices with problems in inaccessible areas or problems which cannot easily be solved using Internet tutorials or other instructions, or, of course, any objects that are particularly dangerous, have all proven to be unsuitable. As a general rule, valuable antiques, works of art, musical instruments, medical auxiliary devices and electric devices or appliances with increased risk potential (e.g. devices that operate on high-voltages) should not be accepted for repair.

# Linking in with other school subjects and other topics



In addition to the outcomes already described, the Student Repair Shop also offers a variety of opportunities to link the Shop's learning outcomes with material from other school subjects and other topics, especially the topic of sustainability. Experience also shows that the Student Repair Shop and the spontaneous or structured discussion groups associated with it can be wonderfully integrated into lessons about technology or ethics and technology. For example, when students discover that certain devices are glued together or have special screws so that the "average consumer" can't open them, and thus cannot repair them and will have to throw them away, you can discuss planned obsolescence with them.

Ever-new and appealing design tempts young people to consume more and more and to consume faster, but they are not the only ones tempted. Children are also seduced, and this is partly responsible for the phenomenon known as psychological obsolescence. We asked students which iPhone model they owned and why they chose it. From their answers, it quickly became clear that the newer phones they had chosen didn't have more functions, or only had a few more functions, but they were, for example, flatter than the older phones. Here are some real-life examples of what can be learned for middle and high school **physics classes**:

In a steam iron, the small pump used to spray distilled water and produce steam had stopped working. The students had to gain an understanding of how this pump worked before they could repair it. In the process, the topics of pressure, piston pressure and gravity pressure from the mechanics part of the physics curriculum could be reviewed and understood in an applied context.

The bimetallic temperature switch on an electric kettle no longer turned the heating current on. From middle-school physics, students were able to draw on their knowledge of the expansion rates of different metals when heated, understand the mechanism of the switch, and use this understanding to repair it.

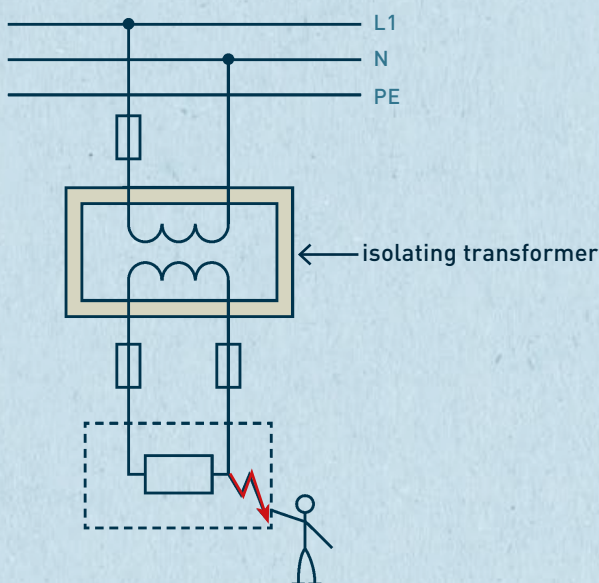
Students used resistance testing on a broken hand mixer to determine that one of the four windings of the motor's electromagnet had burned out. When the windings were switched on, the speed of the mixer gradually increased. By bridging the burnt-out winding, students got the mixer to work again. It had one less speed setting, of course, but the customer was still happy.

There are many examples of repairs to toasters, coffee machines, lamps, etc. that show how the knowledge learned in physics classes can be used for repairs. But these examples also show how much knowledge of physics goes into designing the devices themselves.

# Technical protection measures

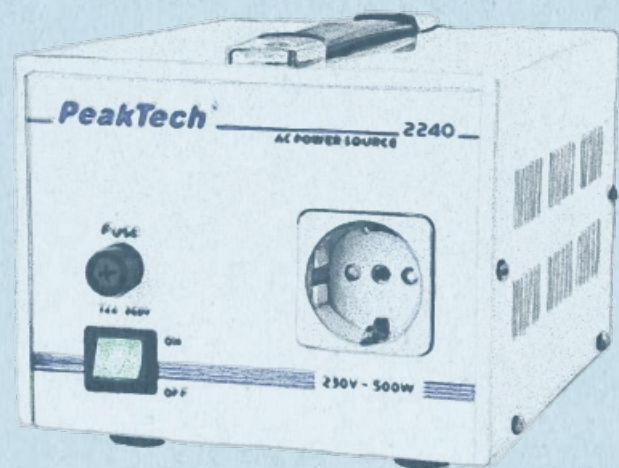
Technical measures can prevent dangerous current from flowing through the human body to a ground or to conductive parts that are grounded. One or more of the following measures can protect against current flowing through the body.

Protective separation and residual current circuit breakers:



In or around the work area, no one should ever be able to come into contact with any object that has grounding potential. Therefore, no devices in work areas (measuring devices, soldering irons, floor lamps, transformers, e.g. for toys to be repaired, etc.) are to be connected directly to the consumer mains; instead, power supply must be provided via an isolating transformer.

If one accidentally comes into contact with the mains voltage of 120 V, the isolating transformer prevents the life-threatening flow of current through the body.



In addition, use of residual-current-operated protective devices (RCD) is always recommended. Luckily, these are also inexpensive and easy to obtain. All electrical devices are best operated using a power strip that has a residual current circuit breaker (FI). This is triggered when a certain residual current is exceeded, thus separating the affected circuit from the upstream network. When purchasing RCDs, care should be taken to ensure that the residual current of the FI circuit breaker is rated a maximum of 0.03 amperes and that the switch-off time is a maximum of 20 milliseconds.

# Advice on safety while working

## Hazards in the woodworking shop:

In general, all the precautionary rules of any woodworking workshop apply. All sharp tools and instruments, e.g. saws, knives, and power tools of any kind require special attention to safety considerations and should be used with caution.

**Rotating machines may not be operated when wearing loose-fitting clothing. Students working with power tools must be instructed on their proper use in advance and supervised by the repair instructor while they are operating such equipment.**

**A well-equipped first-aid kit must be available and easily accessible at all times.**

## Hazards of soldering work:

Soldering irons are hot – and students are still learning. Having a cold pack and burn ointment on hand provides quick relief in case of emergency.

Soldering irons must always be put back into the holders provided. If the hot end of a soldering iron comes into contact with any flammable material, there is a risk of fire.

**Important: When soldering with students, the use of lead-free solder and the wearing of protective goggles are mandatory!**

## Electrical hazards:

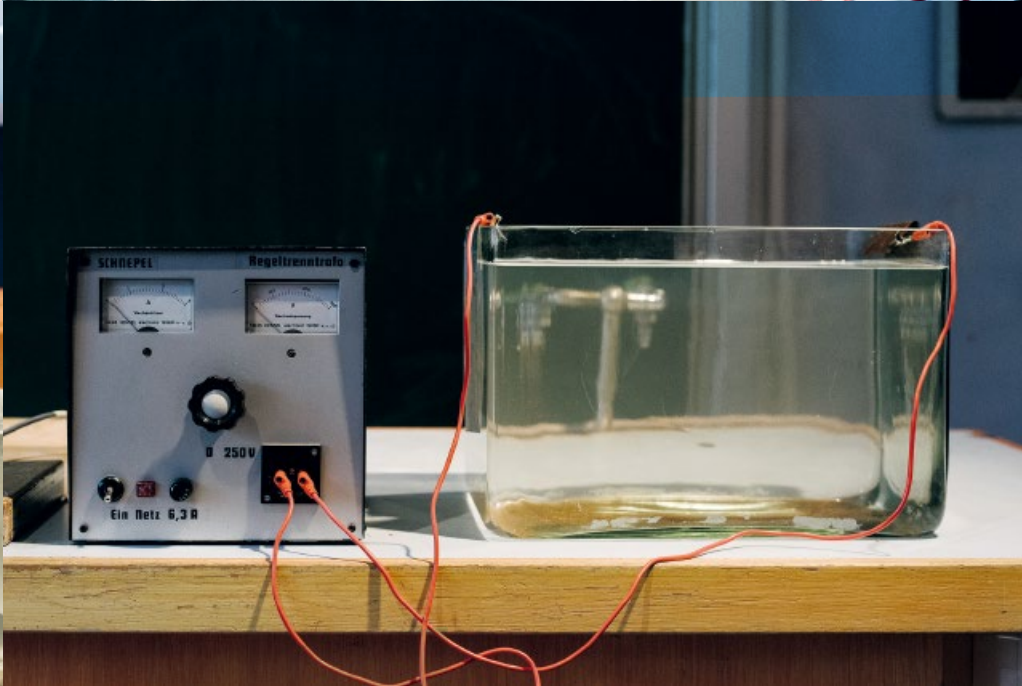
To ensure everyone's safety when repairing electrical equipment, you may want to consult the Occupational Safety and Health Administration (OSHA)'s publication "Electrical Safety in the Workplace", available for download at [https://www.osha.gov/sites/default/files/2019-03/electrical\\_safety\\_manual.pdf](https://www.osha.gov/sites/default/files/2019-03/electrical_safety_manual.pdf)

and

the Centers for Disease Control and Prevention (CDC)'s National Institute for Occupational Safety and Health (NIOSH) self-inspection checklist for schools, available at <https://www.cdc.gov/niosh/docs/2004-101/chklists/n53ele~1.htm>

These resources provide a lot of important information that we hope will be useful for developing your own safety concept.

# Student and customer safety



## Student safety

Before they are allowed to do any repairs, students receive a special “hands-on” safety briefing about the dangers of electric current. Here we describe the effect of electric current on the muscles in the body. If a current of approximately 20 mA flows through a person’s body, the muscles contract, making it impossible for that person to let go of the source of the current.

In order for students to experience this effect, we carry out an experiment from the book **“Wesenszüge der Elektrizität”** (The Characteristics of Electricity) by Rudolf Cantz<sup>18</sup>. For this experiment, we fill a rectangular container made of glass or plastic that is about 25 cm (10 inches) long with tap water and fit it with two opposing metal (e.g. copper) electrodes on the narrow ends. Using an adjustable isolating transformer, we apply an alternating current of 15 to 30 volts to the electrodes. A student is then allowed to put their hand into the water and observe exactly what they perceive. When their hand is placed across the container perpendicular to the longer sides, the student feels relatively little (unless they have a fresh cut or scrape somewhere on that hand, in which case they will feel a twinge there). They then gradually turn their hand so that is increasingly parallel to the longitudinal sides of the container. As they do so, they feel an increasing tingling and a kind of pulling. These both get stronger when the student spreads their fingers. In addition, they may notice that they are barely able to grasp, for example, a coin placed at the center of the bottom of the container.

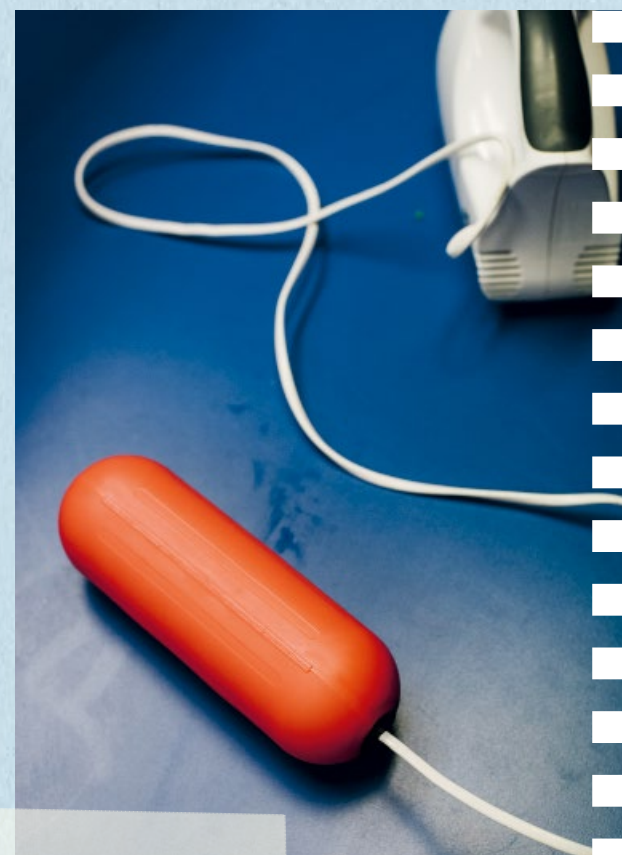
Then we explain to the students that it becomes really dangerous for humans when, on its way through the body, current flows through the heart. At an operating voltage of 120V (the voltage in a U.S. wall socket), a current of approx. 120 mA (milliamperes) flows through the human body from hand to hand. Ventricular fibrillation can occur from as little as 80 mA. This means that there is a danger to human life. In ventricular fibrillation, the many heart muscle fibers contract completely independently of one another: the heart “fibrillates”, its pumping action is suspended. As a result, the circulation of blood collapses. This is referred to as cardiovascular arrest, which leads to a reduced supply of oxygen to the organs, including the brain.

We draw the students’ attention to this and explain why we never repair equipment “under power”, i.e. we never repair equipment while it is plugged in. We point out that students should never do this at home either. To be on the safe side, in our workshop we use a waterproof cable box as a protective cover which is put over the power plug of the device to be repaired and which makes it impossible for students to connect the device to a power outlet.

The protective cover is designed in such a way that students can still check the contact resistance and thus detect a defective power cord as a possible problem.

Many of the problems with inoperative electrical equipment are mechanical, caused, for example, by broken plastic switch levers. Electronic components such as transistors, resistors or capacitors rarely malfunction; if they do, the defective component can often be discovered by visual inspection (they will look “carbonized”) or by the circuit board showing signs of heat. These components can then be removed and tested using a multimeter for resistors, diodes and transistors. Heating windings, motor coils and transformers can also be tested by measuring the contact resistance. There is no danger to the students with any of these measurements, because the meter only applies voltage from the multimeter’s battery to the component when measuring resistance and then measures that current flowing through whatever it is that is being tested. The multimeter then calculates the resistance value from the voltage to current ratio.

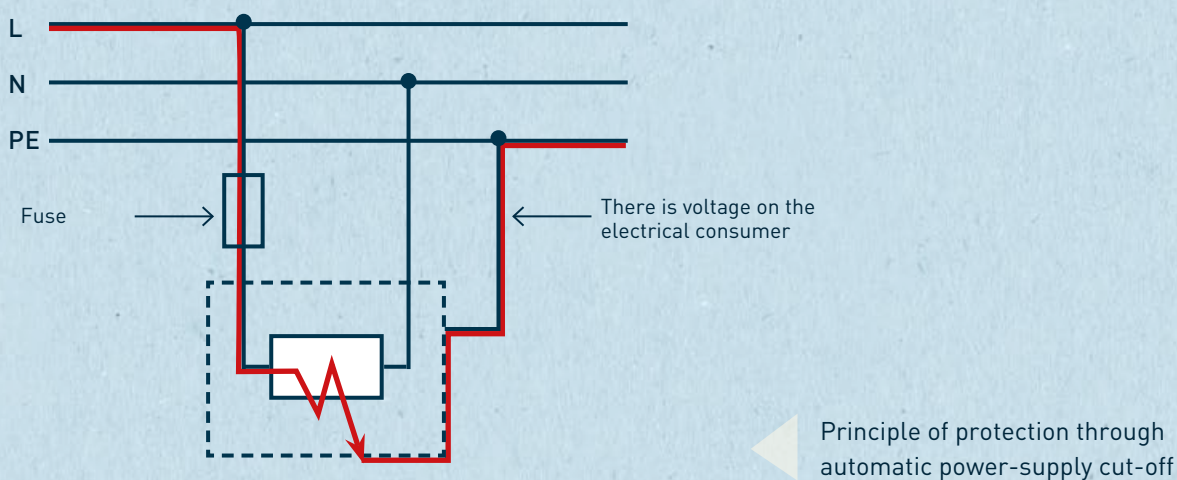
<sup>18</sup> Cantz, Rudolf, *Wesenszüge der Elektrizität* (The Characteristics of Electricity), Kooperative Dürnau, 1986



protective cover

## Manufacturers technical protective measures

During this safety instruction, we also explain the various measures that manufacturers of electrical equipment have taken to protect consumers from electric shock. As a basic protection, all parts that are live during operation are covered or sheathed with insulation. We explain why it is so important that the grounding conductor is connected to the metal housing of any electrical appliance. If, for example, a live wire has come loose and is resting on an appliance's conductive metal housing, the housing will be under current, and current will flow from conductor L1, via the housing and the PE grounding conductor, back to the voltage source. This current effectively corresponds to a short-circuit current and triggers the overcurrent protection device (fuse F) and the power supply is automatically switched off.



## At low voltages, students are allowed to repair objects that are drawing current

As necessary, students are allowed to work on extra-low voltage devices that are "under power" if their power supply is safely isolated from the mains. In direct contact, AC voltages of less than 25 volts and DC voltages of less than 60 volts are considered to be low. You can ensure separation from the 120V mains by using isolation transformers. This allows students to run diagnostic tests while they repair electric toys that are connected to low-voltage transformers, such as train sets, or any battery-operated devices, such as cell phones, smartphones, remote controls, toy cars, etc., while they are under power. However, it is very important to emphasize that careless handling can trigger a short circuit, which can be especially dangerous with lithium-ion or lithium-polymer (Li-ion / LiPo) batteries.

## Customer safety

Before a repaired device is handed over to the customer, we recommend performing a routine safety inspection. (German law requires that this inspection conform to the DIN VDE 0701 standard). For this inspection, we recommend using an appropriate testing device to measure the protective conductor resistance, insulation resistance and the substitute leakage current. German law requires that students carry out these safety inspections in the presence of a qualified electrician.

When the device is still open for repairs, it should also be visually inspected. The following checklist can be used for these visual inspections:



# Checklist for the visual inspection of electrical equipment

## Visible defects in electrical equipment will typically involve

### PLUGS, CONTACTS AND SOCKETS

- loose, bent or fused plug contacts
- cracked, deformed or chipped housing or parts thereof
- detached or damaged kink protection
- loosened or detached strain relief
- improperly performed repairs

### CORDS AND CABLES

- sections that have been patched
- damaged insulation
- brittleness (e.g. due to UV radiation, heat or age)
- deformities that might indicate breaks or kinks inside the cord and which can be felt through the insulation

### HOUSINGS

- pieces of housing are broken or chipped
- arcing spots
- conductive dirt or moisture
- improperly performed repairs
- deformations
- clogged or dirty ventilation openings

At the end of each repair, students check to make sure the device is in proper working condition in the presence of an electrician; if necessary, the device will be restored to proper working condition, even if this was not the original reason for repair: e.g. damaged power cord, defective strain relief, sharp edges, etc.

All safety-relevant features, e.g. temperature cut-off switches, voltage monitoring, current limiting, fuses, etc. must be working and in order, otherwise safe operation of the device cannot be guaranteed.

**Note: If the device test does not pass the safety inspection, further use of the device is life-threatening and therefore not permitted under any circumstances. The owner must be informed and the device must be disposed of.**

**Testing according to DIN VDE 0701:** \_\_\_\_\_

Receipt of order form number: \_\_\_\_\_

Checked with device: \_\_\_\_\_

Serial number: \_\_\_\_\_

Checked by: \_\_\_\_\_

Remarks: \_\_\_\_\_

\_\_\_\_\_

### Visual inspection:

Casing in order: i.o. Yes  No

Connecting cables and plugs : i.o. Yes  No

Strain relief device: i.o. Yes  No

Safety devices: i.o. Yes  No

### Measurement (tick the appropriate):

Protection class SK I

Protection class SK II

Protection class SK III

Only measurement on load possible, no further measured values can be collected.

Protective conductor resistance: i.o. Yes  No

Insulation resistance: i.o. Yes  No

Substitute leakage current: i.o. Yes  No

**Test passed:** Yes  No

A person wearing a blue hoodie is sitting at a blue desk, filling out a receipt form. They are using a pink marker to write on the form. The form has several sections, including a table for customer information and a section for the receipt details. The background is a blue wall with a green vertical stripe on the right side.

# Liability

We recommend that you familiarize yourself with the topic of liability in detail. After appropriate research here in Germany, we instituted the following policy: The customer must agree to release the Student Repair Shop from all liability (= obligation to pay damages) when the defective device is submitted for repair, as confirmed by the customer's signature in the corresponding section of the receipt of order form.



# Appendix

List of tools

Examples of successful repairs

Receipt of order form

Room plan



"You just need that for life!"  
(Student, 10th grade)

# List of tools










## Tools hanging on the tool wall at each two-student workstation

combination pliers 	wire-cutting pliers 	set of screwdrivers 
needle-nose pliers 	set of combination wrenches 	LED flashlight 
bent long nose pliers 	set of ball-end Allen- or hex wrenches 	set of precision tweezers 
insulation stripping pliers 	set of torx drivers 	dust brush 
side cutter for electronics 	machinist's hammer 	utility knife 
	scissors 	safety glasses 

## Test equipment and tools on the work surface at each workstation

set of precision bits 	100-piece bit set 	soldering station 
swiveling vise 	multimeter for diodes and transistors 	solder sucker 
DC power supply 30 V 5 A 	sorting tray for screws 	lead-free soldering wire 
test cable (1 meter) 	test probes 	Hirschmann safety test probes 

## Tools and test equipment in the tool trolleys

Vernier caliper 	Voltage detector 	set of drill bits for wood 
end-cutting pliers (nippers) 	set of pin punches 	set of diamond files 
locking pliers 	center punch 	set of drill bits for metals 

circlip pliers inside



bearing puller tool



set of wood rasps



circlip pliers outside



cable end set w/ tool



soft-face hammer



backsaw (fine)



crimp connector set w/crimping tool



channel-lock pliers



bar clamps



hacksaw



cordless screw driver



assortment of bolts, nuts & washers



### Bicycle repair

bicycle tool kit



foot pump (w/ pressure gauge)



bicycle repair stand



innertube patch kit



shift / brake cables with cable ends



lightbulbs



bicycle chain lube



bicycle lights, front & rear



cable



innertube valves



brake shoes



spokes and nipples



combination wrenches (metric)



set of ball-end Allen/hex keys



wire brush



hand-cleaner



grease-proof floor mat



set of tire-irons



### Lubricants, cleaners, glues and solvents

sewing-machine oil



"zip" (cable) ties



terminal strips



heat shrink tubing



flower binding wire



duct tape



various adhesives (glues)



solvents (naphtha, ethyl alcohol)



disposable shop towel



# List of tools

Woodshop tools					
drill press		scroll saw		joiner's bench	
cordless screw driver with set of bits		wood lathe		orbital sander	
circular saw		jigsaw		shop-vac with automatic device socket	
beech dowel stock, smooth		set of wooden dowel-plugs		flat dowel router	
sandpaper (various grits)		plastic wood		hand sander	
pencils		cork sanding block		assortment of wood screws	
assortment of nails		hammer		soft-face hammer	
set of Forstner drill bits		set of drill bits for wood		set of counter sink bits	
set of wood rasps		bar clamps		set of various pliers	
handsaw		backsaw (fine)		set of Japanese woodworking saws	
set of screwdrivers		carpenter's squar		bevel	
tape measure		pocket rule		Vernier caliper	
smoothing plane		set of wood chisels		carpenter's mallet	
masking tape		safety glasses		wood glues (express & regular)	
end-cutting pliers		awl			

### Safety equipment

Isolating transformer



power strip with circuit breaker



waterproof cable box



### Specialized test equipment

storage oscilloscope



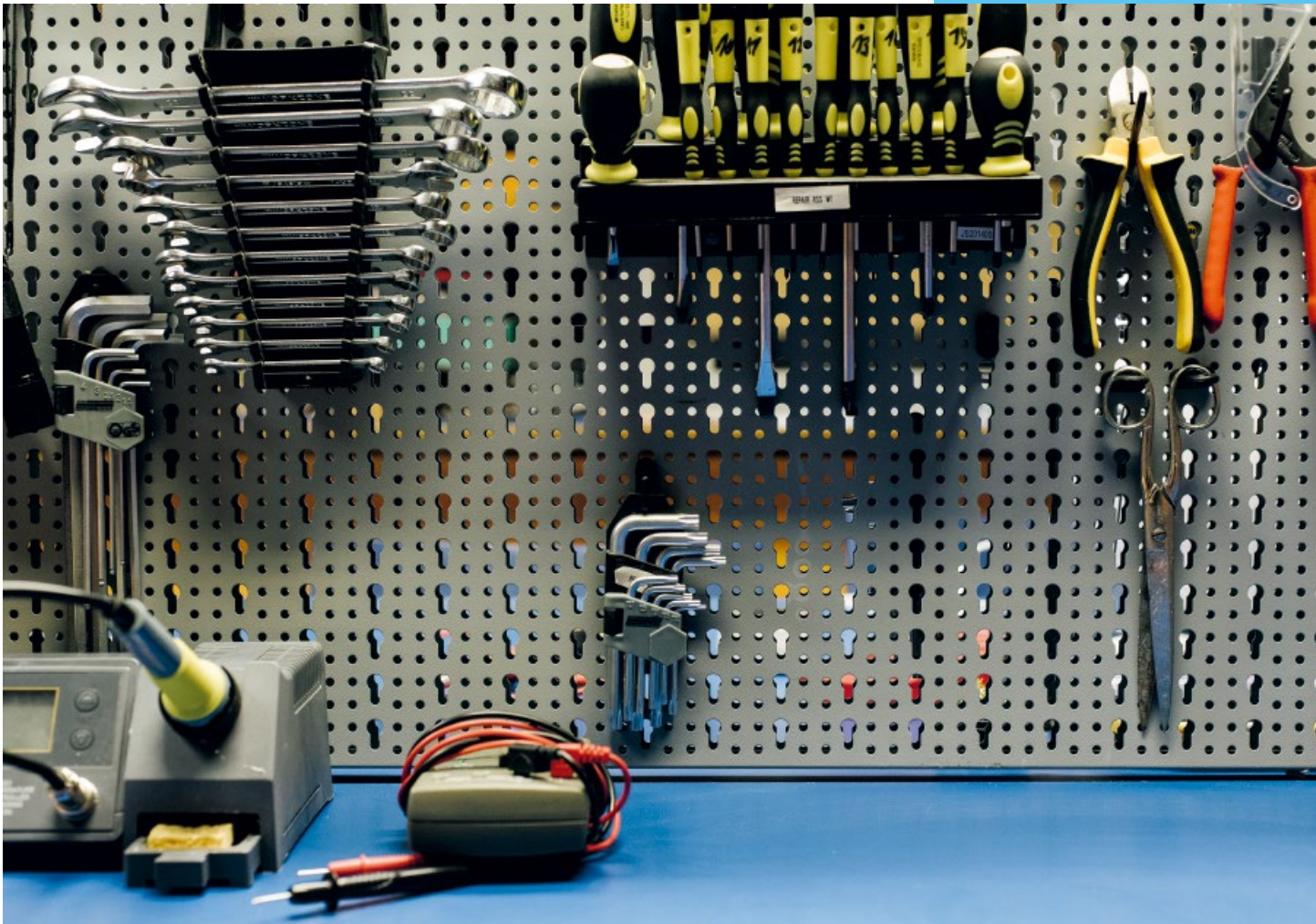
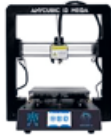
multifunctional multimeter device tester



(e.g. Benning Device Tester St 725 050316)

### Special equipment

3D printer







	A	Gerät	Fehler	Reparatur	Erfolg + Aktion	VDE-Prüfung
1	A	Digitalkamera (Sony W800)	Objektiv klemmt, Sturz oder Sandschaden	zerlegt (Philips 00+000 + Pinzette erforderlich) und - Objektiv aus anderer Kamera (ebay 20 Euro) eingebaut	erfolgreich	
2	L	Toaster	keine Funktion	defekten Transistoren erneuert	erfolgreich	
3	L	elektrischer Rührer	Schalter defekt	Schalter geklebt	erfolgreich	
4	L	Laminiergerät	Zähne am Zahnrad ausgebrochen (Überlast?)	Angebot für Laser-Cutter-Zahnrad angefordert aber nicht erhalten	nicht erfolgreich	
5	T	Kassetendeck Sony	Riemen gealtert und gerissen	durch Haushalt-Gummis ersetzt = kurzzeitige Lösung	erfolgreich	
6	L	Kaffeemühle	keine Funktion	defekten Triac ersetzt	erfolgreich	
7	N	Kombigerät (Fax, Scanner, Drucker)	keine Funktion	Wackelkontakt am Kabel behoben	erfolgreich	
8	E	Wasserkocher	Deckelscharnier defekt	neues Scharnier herstellt und eingeklebt	erfolgreich	
9	E	Wasserkocher	keine Funktion	Temperatursicherung erneuert		
10	E	Nußknacker	Stift im Hebel fehlt	Sift duch abgesägten Nagel ersetzt	erfolgreich	
11	E	Lampe	keine Funktion	Kabelbruch, Kabel erneuert	erfolgreich	
12	E	Lampe	keine Funktion	defekten Schalter erneuert	erfolgreich	
13	K	Lampenschirm, Lampenfassung	Plastikgewinde defekt	Einkleben der Lampenfassung mit Zwei-Komponenten-Kleber	erfolgreich	
14	V	Nokia Handy E51	Einschaltknopf defekt	keine neuer Einschaltkopf zu finden	nicht erfolgreich	
15	C	Kaffeemaschine	zu wenig Wasser	verkalkte Düse gereinigt	erfolgreich	
16	C	Haar-Glätteisen	keine Funktion	Ersatz Regelungsplatine nicht möglich	nicht erfolgreich	
17	T	Mehrfachsteckdose	keine Funktion	neu verdrahtet	erfolgreich	
18	A	Kopfhörer	keine Funktion	Kabelbruch, neu angelötet	erfolgreich	
19	A	Kopfhörer	keine Funktion	Kabelbruch, neu angelötet	erfolgreich	
20	J	Wasserkocher			erfolgreich	
21	N	Nähmaschine	dreht sich nicht mehr	gebrochenes Gelenk geklebt	erfolgreich	
22	F	Autofunkschlüssel	Lötstellen am Batteriekasten haben sich gelöst (Sturz?)	zerlegt, unzugängliche Lötstelle durch dünnes Kabel verbunden	erfolgreich	
23	F	Nähmaschine	keine Funktion	Kabelbruch, Kabel erneuert	erfolgreich	
24	V	Spielzeug			erfolgreich	
25	K	Pfeffermühle			erfolgreich	
26	K	elektrische Schere			erfolgreich	
27	K	Lampe			erfolgreich	
28	V	Düsenstrahlantrieb	defekter Accu	LiFePO4 Accu gekauft und eingebaut	erfolgreich	
29	S	Overhead-Projektor	Aufhängung des Spiegels gebrochen	Aufhängung geklebt und neu verschraubt	erfolgreich	
30	F	Holzspielzeug			erfolgreich	
31	F	Akku-Bohrer	kein Fehler gefunden	zerlegt und wieder montiert	erfolgreich	
32	I	Stimulator	keine Funktion	unterbrochene Leitung angelötet	erfolgreich	
33	L	Maßband	defekter Einzug	kein Ersatzteilkauf möglich	nicht erfolgreich	
34	V	Lampenschirm	Schalter defekt	neuer Schalter	erfolgreich	
35	F	Fernseher	Fehlfunktion	neues Netzteil	erfolgreich	
36	T	Steckdosenleiste	keine Funktion	neuen Schalt eingebaut	erfolgreich	
37	J	Lampenschirm	keine Funktion	Kabel erneuert	erfolgreich	
38	F	Fahrrad	Gangschaltung defekt	Gangschaltung neu justiert	erfolgreich	
39	F	Fahrrad	Speichen gebrochen	6 Speichen erneuert und "Achter" entfernt	erfolgreich	
40	T	Espressomaschine	keine Funktion	Durch Überhitzung defekter Termoschalter, kein Ersatzteilkauf möglich	nicht erfolgreich	
41	L	Tischlampen	keine Funktion	neuer Schalter und Kabel	erfolgreich	
42	F	Flipper	teilweise fehlende Funktion	fehlende Schaltpläne	nicht erfolgreich	
43	M	alter Barometer	falsche Anzeige	neue Eichung des Barometers	erfolgreich	
44	C	Wanduhr	Zeiger kommt über Dreiviertelstellung nicht hinaus	neue Batterie eingebaut	erfolgreich	
45	F	Stereoanlage	keine Funktion des CD Player	Reinigung und Neujustierung	erfolgreich	
46	F	Massagegerät	Bruchstelle	zu geklebt	erfolgreich	
47	C	Brille	Brillengestell gebrochen	geklebt	erfolgreich	
48	L	Armbanduhr	Sekundezeiger abgefallen	Zeiger wieder moniert	erfolgreich	
49	L	Kaffeemaschine	zu wenig Wasser	verkalkt	erfolgreich	
50	F	Pferdchen	gebrochenes Bein	Nähte der Hülle geöffnet, Futter entfernt, Traggestell geschweißt und wieder zugenäht	erfolgreich	

50 Antje

51 Antje

52 Dorot

53 Dorot

54 Dorot

55 Sophi

56 Waltr

57 Waltr

58 Diete

59 Laura

60 Meik

61 Benja

62 Leon

63 Herr

64 Walt

65 Soph

66 Soph

67 Bene

68 Bene

69 Ann

Ersatzteilkosten	Spende
1,94 €	8,06 € 10,00 €
	30,00 €
0,53 €	
3,69 €	50,00 €
	10,00 €
	20,00 €
43,95 €	
	30,00 €
8,99 €	
3,96 €	5,00 €
5,00 €	
3,96 €	10,00 €
	15,00 €
5,40 €	14,60 €
7,25 €	
	5,00 €
3,00 €	2,00 €
	10,00 €
	20,00 €
28,75 €	21,25 €

These are the first few pages of the repair documentation.

By spring 2022, more than 700 objects had been successfully repaired.

Pferdchen	gebrochenes Bein	Nähte der Hülle geöffnet, Futter entfernt, Traggestell geschweißt und wieder zugenäht	erfolgreich
Brot Schneidemaschine	hat nicht funktioniert	auseinandergenommen, wieder zusammengeschaubt	erfolgreich
Toaster	Feuer aus dem Gerät	verschmutzt, vermutlich sind Brotreste verbrannt	zerlegt, gereinigt = erfolgreich
Nachttischlampe	Teil der Fassung fehlt	geprüft, kein Defekt feststellbar	erfolgreich
Pürierer	unbekannter Fehler	geprüft, kein Defekt feststellbar	erfolgreich
Kopfhörer	rechter Kopfhörer kaputt	Kabel abgeschnitten, neu wieder zsm gemacht	erfolgreich
Stereoanlage	CD drehte nicht	aufgemacht, Schalter geprüft, zsmgeschraubt	erfolgreich
Kühlschrankfach	gebrochenes Fach	geklebt	erfolgreich
Lampe	Transformator defekt	neuen Trafo eingebaut	erfolgreich
Fahrrad	Lampe defekt	Kabel neu angeschlossen	erfolgreich
Stuhllehne	gebrochen	neu verleimt	erfolgreich
Armbanduhr	Verschluss schließt nicht mehr	Verschluss zurechtgebogen	erfolgreich
iPad		Ersatzglas iPad	nicht erfolgreich
Laptop			
Gießkanne	undicht	gelötet	erfolgreich
Ohringe	gebrochen	gelötet	erfolgreich
MPE Player			nicht erfolgreich
Fahrrad	Gangschaltung defekt	Gangschaltung neu justiert	erfolgreich
Fahrrad	Bremskabel gerissen	neues Bremskabel montiert	erfolgreich
Armbanduhr	Sekundenzeiger	neu montiert	erfolgreich
Kugelbahn	Holzteile der Wand fehlten oder habe sich verzogen	Neue Wandteile herstellt und montiert	erfolgreich
Kochtopf	fehlende Griffe	neue Griffe aus Holz hergestellt und montiert	erfolgreich
Spieldose	Scharniere defekt	Scharnierstift eingebaut	erfolgreich
Kaffeemaschine	verkalkt	gereinigt	erfolgreich

Lfd. Nr.	Kunde	Repariert von	Gerät	Foto Gerät	Foto Defekt
198	Ho.	Zacharias	Getreidemühle		
199	H.Hu	Jakob	Staubsauger-Roboter		
200	Schu.	Amelie	Dampfbügel-eisen		
201	Dö.	Finn	Rührgerät Kitchenaid		
202	M. Be.	Camillo & Arvid	Zwei elektrische Zahnbürsten		
203	Kinder-garten	Ida & Emma & Philine	Spielzeug-Hahn		
204	F. Re.	Franziska	ferngesteuertes Polizeiauto		
205	K. He	Jule & Pina	Radio-CD-Player-Kasset-tenrecorder		
206	K. Be	Martha	Gartenleuchte		
207	U. Sch.	Arvid & Camillo	elektrische Zahnbürste		
208	Halle 2	Arthur	Hubschrauber		
209	A-M. L.	Zacharias	Staubsauger		

Fehler	Reparatur	VDE-Prüf.	Kosten in Euro	Spende in Euro
Motor dreht sich nicht mehr; durch feuchtes Mahlgut verklebt	zerlegt, gereinigt - funktioniert	bestanden		
Display zeigt die Fehlermeldung Reinigung, obwohl Bürste sauber ist.	Im Bürstenteil und im Rad haben sich viele Haare verheddert, sodass die Bürste aus der Verankerung gesprungen ist und sich nur noch schwer drehen konnte.	entfällt		
Temperatur-Sicherung durchgebrannt	Temperatur-Sicherung erneuert	bestanden	1,95	
Schalter macht keinen Kontakt	Schalter neu justiert	bestanden		10,00
keine Funktion, kein Leuchten	Akkus defekt, neuen Akku eingelötet	entfällt	12,48	
Gebrochene Radachse	Hahn musste "operiert" werden. Anschließend wieder verleimt und neu gestrichen.	entfällt		
Lenkung spricht über Fernsteuerung nicht an.	Gebrochene Achse im veränderbaren Widerstand der Fernsteuerung geklebt	entfällt		
Durch Sturz Kopfhörerbuchse gebrochen. Seitdem kein Ton.	Kopfhörerbuchschalter durch Lötung überbrückt	bestanden		10,00
Stecker lose, Birne kaputt	Stecker neu montiert, Schrauben gelöst und Gewinde nachgeschnitten, neue Lampe eingebaut	bestanden		
Motor dreht, aber Bürste bewegt sich nicht	Gebrochene Verbindung. Verbindung konnte durch vorhandenes unreparierbares gleiches Modell ersetzt werden.	entfällt	keine	10,00
Nach Absturz gebrochene Rotorblätter	Defekt Teile über Internet bestellt und eingebaut	entfällt	22,45	
keine Saugleistung	Kohlen des Elektromotors erneuert	bestanden	7,44	20,00

# Receipt of order form

Date

Order No.

Repaired by: student student	Customer: first name last name
Telephone no.:	Email:
item to be repaired:	Year made:

What is broken? What still works?

Find out about the customer's relationship to and history with the device. Ask questions like: Why is it important that your device is repaired? Do you associate a special story with the device?

Desired outcome of repair (including date of completion)

Cost of parts (max. )

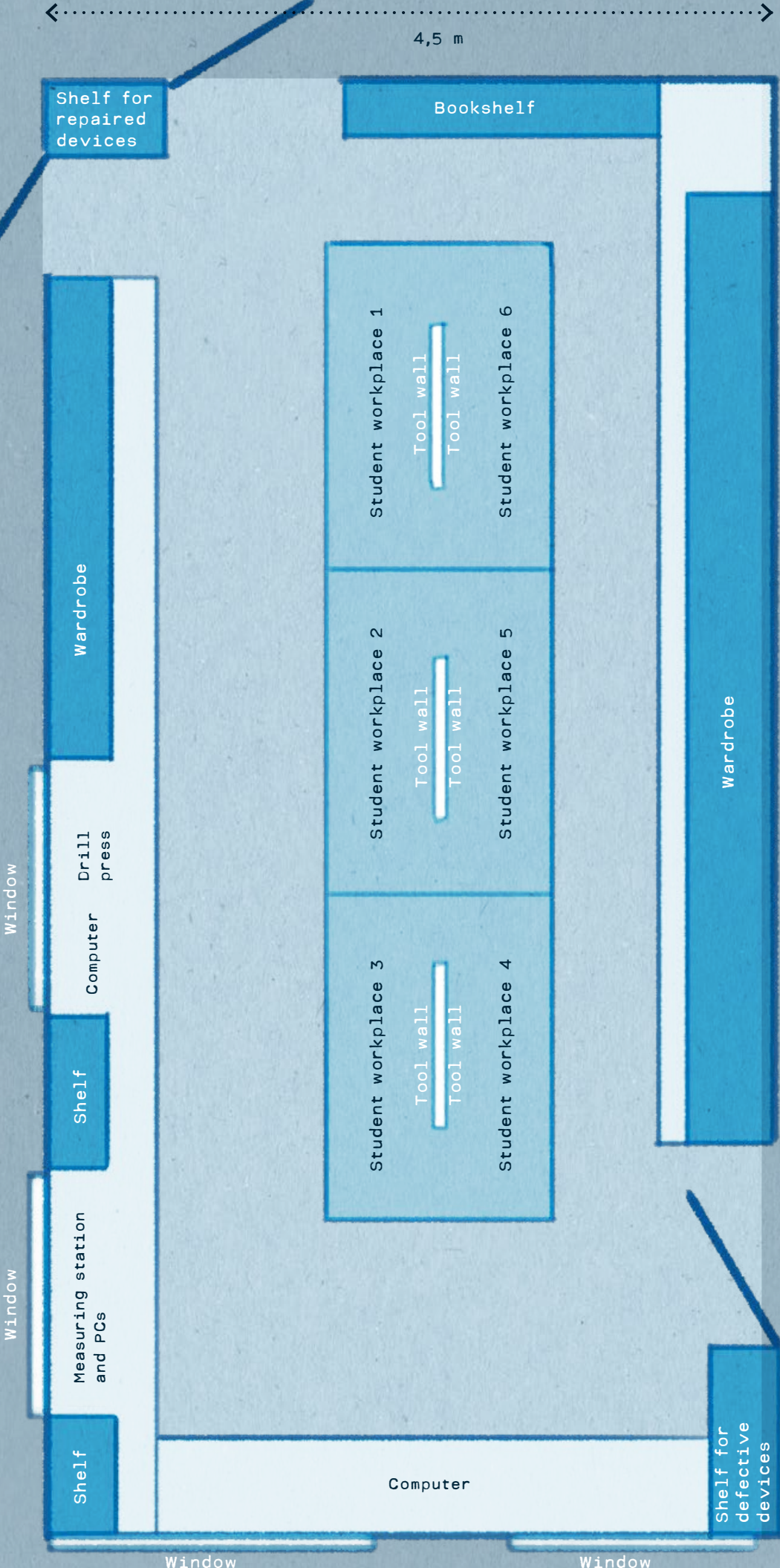
Consequences of failed repair or even further damage to item

I hereby release the Student Repair Shop from any form of liability, i.e. the obligation to pay damages in the event of a failed repair.

\_\_\_\_\_  
Customer signature

Date	Start of repair	Experiences (when taking item apart, broken parts, cause of malfunction) – completed (yes/no), customer comments	preliminary result parts needed + cost
Date			
Date		Experiences (when taking item apart, broken parts, cause of malfunction) – completed (yes/no), customer comments	





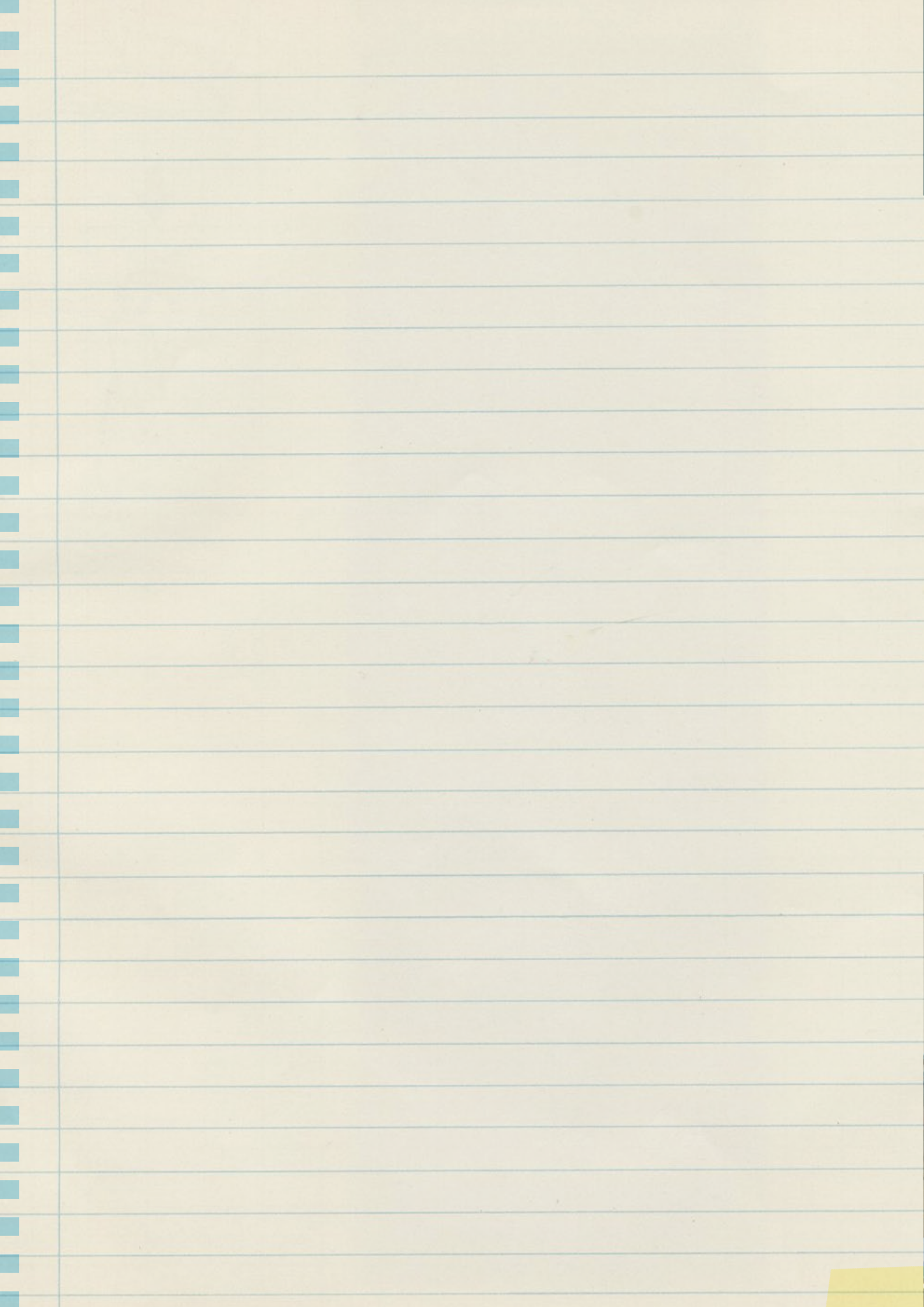
4,5 m

9 m

Room plan







# Here's how you can contact us

Email: [reparatur@waldorfschule-schwabing.de](mailto:reparatur@waldorfschule-schwabing.de)  
[www.schueler-reparaturwerkstatt.de](http://www.schueler-reparaturwerkstatt.de)

The whole point of this handbook is to encourage schools and teachers to establish student repair shops of their own. So, we are very interested in hearing about your experiences and answering any questions that you may have. Schools that would like to start their own student repair shops are welcome to contact us via email at:

[reparatur@waldorfschule-schwabing.de](mailto:reparatur@waldorfschule-schwabing.de)

Or by telephone at **+49 89-38014025**  
 (ask for Walter Kraus).

You are also cordially invited to arrange a visit to come see the Student Repair Shop in Munich.

You can find us on Facebook:

<https://www.facebook.com/Reparaturunterricht/>

Instagram:

<https://www.instagram.com/fixingforfuture>

YouTube:

[https://www.youtube.com/channel/UCntfu9zC\\_zDGP9hMt-FL4e4Q](https://www.youtube.com/channel/UCntfu9zC_zDGP9hMt-FL4e4Q)

and on Twitter:

<https://twitter.com/FixingforFuture>

We've also uploaded repair advice with photos and videos to these websites.

We encourage schools to network with each other and to join national and international repair networks.

Please let us know what you and your school are doing. We would love to hear from you, and we will be happy to answer any questions you may have!



Dinge reparieren, d.h. die Welt

ein kleines bisschen besser machen

"Repairing things makes the world  
a bit of a better place -

und wer das möchte, der muss  
this book is a must-read for doing

that work."

dieses Buch lesen.

Prof. Harald Lesch

Professor of Physics,  
Ludwig Maximilian University of Munich

Harald Lesch