

# Portable and Flexible Tech Setups for Blended Synchronous University Courses

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# Portable and Flexible Tech Setups for Blended Synchronous University Courses

First complete version, February 2022

*by Stefan Pauliuk*

## Background and synopsis

Professional videoconferencing solutions connect a group of team members or students in a meeting room or lecture hall with a number of online and remote participants, allowing for smooth exchange of audio, video, and screen sharing at high quality.

After two years into the Corona pandemic, at many German universities, such videoconferencing solutions are still largely unavailable for teaching. At the University of Freiburg, in particular, where the available infrastructure already provides a good and very reliable basis for many facets of e-learning, there are still only three seminar rooms with a fixed videoconferencing system and a good dozen rentable mobile devices mostly suitable for small groups and single events only. This is insufficient to support what can be considered the core application of blended university teaching: the regular video-conferencing of lectures, seminars, and tutorials. As a consequence, more teaching than necessary happens online only, with all the depressing ramifications.

This report describes a makeshift solution to the problem: Several low-cost, off-the-shelf, and flexible setups for converting any lecture hall or seminar room with WiFi and a projector (and loudspeakers, if available) into a videoconferencing location.

In this report, I describe the different setups that were developed, tested, and used successfully during about 150 lectures, seminars, tutorials, and thesis defenses during the winter semester 2021/2022 and report our fixes and workarounds to the problems we encountered.

## One sentence summary

This stuff here saved the teaching of our group during the fourth Corona semester!

## Disclaimer

This report only covers setups involving Zoom Meetings on Windows 10.

It does not contain a systematic market screening and/or professional test of different hardware and software components. It's a report on what works down on the road. Parts of it may read like an advertisement for certain products, while other, maybe even better solutions, are not even known to me.

My conflict of interest that introduces a strong bias and limits my neutrality here is that I want these things to run smoothly without investing too much time and effort. Therefore, there is a clear path dependency to stay close to the platforms (Windows, Zoom, ...) that I am already familiar with and that have been proven to be extremely reliable. I also directly implemented some of the tips from colleagues.

There is no financial conflict of interest and no special support other than the usual support from our e-learning team and basic customer support from Zoom.

## What matters?

These are the technical points that one needs to worry about when setting up a videoconferencing solution (ordered by importance):

1. Smooth internet connection (not in your hands)
2. Smooth video communication application (there are many of them, but Zoom Meetings stands out as very versatile, widely used and extremely reliable and is also the starting point here)
3. Clear audio signal in both directions (!)
4. Smooth Screen sharing
5. Activate the students: questions, breakout-discussions, sample calculations, etc.!
6. Good camera signal in both directions, esp. for transmitting blackboard writing

There are also social (acceptance by all participants to have their image recorded and broadcast) and legal aspects, which are not considered here but may become relevant and even constraining factors in certain situations.

## The basic solution – some hardware, no additional software

### *The basic setup*

The basic step is to leave your laptop's mic, speakers, and camera behind and use an all-in-one high definition webcam and speakerphone. Such standard plug and play videoconferencing systems for offices and small meeting rooms include

- *Logitech BCC 950*, which we have been using in our group since 2017, for ca. 150 EUR.
- *'Meeting Owl Pro'*, which is available from the IT division's media center and our faculty dean's office, purchase price: 1000-1100 EUR.

These setups are plug and play, with readily available auto-install drivers. They integrate microphones, speakers, and camera, and each of these input-output (IO) devices can be separately selected in Zoom (Fig. 1).

They differ in their technical features, and a comparison can be found here [1].

*Logitech BCC 950*: The pickup range of the microphone of the Logitech device (2.4 m [1]) indicates that this is a solution for small teams (up to four participants [2]) and meeting rooms only, and in our group, we have used this device successfully over years to have small team meetings of 2-4 local attendees from our offices. For this purpose, I can recommend this device to every group, it's good value for the money. It does not work well in larger rooms, however, and definitely not if the students are further away than ca. 3 m.

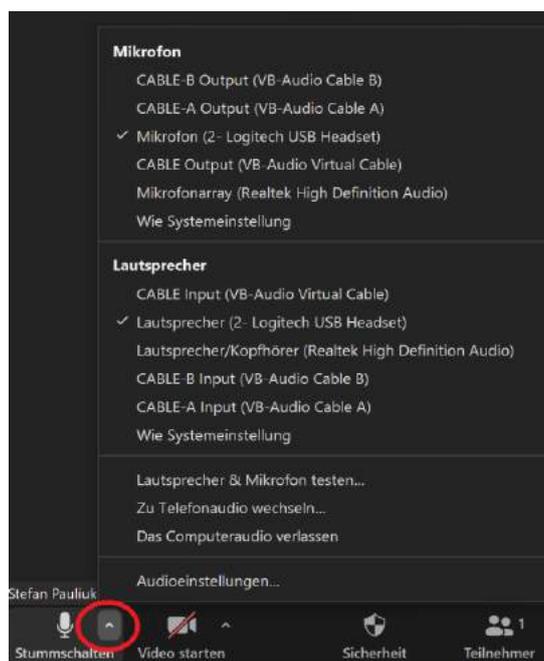
*Meeting Owl Pro*: We rented a Meeting Owl from our IT service's media division and it worked perfectly upon first use, plug and play directly into Zoom. There is also a smartphone app for the owl but we did not need it to change the default settings. We live-streamed group sessions of 5-8 participants sitting in a circle of ca. 4 m diameter around the owl. Video with auto-focus worked smoothly and very well, the audio output (voices of the online participants) was excellent, too.

The critical part, i.e., the recording of the voices of the participants present in the room was of acceptable but not excellent quality: rather echo-ish and dark voices but no noise with Zoom audio filter on and very clear but rather quiet voices with some slightly disturbing general white noise on all signals without the Zoom audio filter on. During a test, switching back and forth between the Owl mics and the USB mics shown in Fig. 5 did not change much, so the Owl is a good substitute for wired microphones in the setting described above and other, similar settings. The main option for improvement seems to lie in a better fine-tuning of the Zoom audio input filter.

**Suitable teaching situations:** The Logitech device is suitable for small team meetings of 2-4 people, and can be used, for example, for supervisory meetings or online exams, where the team sits around a desk. The Meeting Owl can handle larger settings of up to ten people, and can be used for videoconferencing larger team meetings and seminars, for example, small courses and master thesis seminars.

## Wireless microphones with combined receiver

For large groups and/or large rooms, the microphone is the bottleneck: The mike of the all-in-one solution won't capture a good audio signal, which means that contributions from the large student audience cannot be understood by the online participants. That is much worse than not seeing them properly. Therefore, these mics need to be replaced by mics that are placed closer to the speakers. The simplest solution here is to replace the Logitech or Owl microphone by a 'throw-around microphone', i.e., a wireless mike in a box that is passed around in the audience, while the receiver is connected to the teacher's laptop with the Zoom meeting via USB. In Zoom, changing mike, loudspeaker, and camera is easy, as all available inputs and outputs are listed and the desired input source can be chosen (Fig. 1).



**Figure 1:** Crucial: choose audio input and output in Zoom by clicking on the audio settings button. Similar for camera input settings (available on the button right to the audio button, where the red circle is). Select the conference device for mic, loudspeaker, and camera if you only want to use this one, or select the wireless microphone for larger rooms!

**The problem: Zoom Meetings only allows you to select one mike at a time!** But for the classroom, we need at least two: The 'throw-around microphone' and the one the teacher uses! The simple solution to this problem is to buy a set of wireless microphones, where the combined receiver mixes the signals from the two mikes together and sends them to the laptop/Zoom as on common microphone input via USB.

For this combined 'throw-around microphone' solution, Zoom support recommended *Catchbox*, which costs 1000-1100 EUR if purchased together with a second microphone that can be attached to the lecturer/host [3]. I have seen this in action once and it was cool!

Our e-learning division recommended another solution for a quarter of the money, and at an institution funded by public money, the cheaper solution always wins:

The *Rode Wireless Go II* (ca. 270 EUR) features two matchbox-sized wireless mics. One can be placed in a toy for small children with a shoelace and some tape (Fig. 2), and the other one is attached to the lecturer (can also be used with a Lavalier mic, see Fig. 4 and ref. [9]). The receiver sends the combined signal to the Laptop via USB, where it auto-installs and is then selected as audio input in Zoom.



**Figure 2:** The throw-around mic to replace the stationary mic. The toy shown here costs 9 EUR and is available from Müller: <https://www.mueller.de/p/mueller-toy-place-rasselball-148452/>)

The entire setup (without cable connections) is shown in Fig. 3, where a USB port extender is used to also connect a presenter (combined slide advancer and laser pointer). The whole solution (Logitech, extra loudspeakers, Rode Wireless, port extender, extension cable) costs about 500 EUR, which translates into an extra cost of only 5 EUR per lecture in just a single semester with 100 lectures.



**Figure 3:** Components of the setup, with speakers and camera in the background, the Rode wireless microphones and receiver to the right, the presenter in the front, and the USB port extender to the left. Here, the audio signal for the speakers comes from the 3.5 mm jack of the laptop (select Windows Realtek audio driver).

## **Wireless microphones with combined receiver, camera with auto-zoom, and lecture hall loudspeakers**

For live-streaming from large lecture halls, including blackboard writing, another setup was successfully applied multiple times, similar to what is described here by our colleagues from KIT Karlsruhe, who also shared some good tips on this type of equipment [8, 10].

- The Obsbot Tiny Webcam with autofocus and gesture control [7] (ca. 200 EUR extra). See ref. [10] for a few tips on the gesture control!
- An extra 3m USB-C/USB-A cable to connect the camera to the laptop. I wind the cable round the tripod to protect the USB socket of the camera from mechanical damage.
- My father's 50 year old tripod, which is fantastic, as it is still the same old screw! (1/4", 20 threads per inch UNC)
- The Rode Wireless Go II microphones with the throw-around solution as above (Fig. 2) and with one additional Lavalier-mic attached to your collar and connected to the transmitter in your pocket [9]. (The Obsbot Tiny Webcam also has a built-in mic that can be used to transfer the lecturer's voice!)
- The USB port extender
- The speakers of the lecture hall, to which the sound is sent via the HDMI cable

The camera was ordered from a large online retail store on a Tuesday, delivered to my house Friday evening, and successfully used for the first time the following Monday morning! With this setup, I could instantly live-stream my environmental physics classes from a large lecture theatre, including blackboard writing! Student feedback was very positive, and the throw-around mic was a great success, too.



**Figure 4:** Components of the setup for large lecture theatres and blackboard writing. It features the Obsbot camera plus tripod and cable (lying, left), the throw-around and the Lavalier mic plus receiver (right), the port expander (background), an optional slide advancer (center), and the HDMI cable for video and audio output to the lecture hall theatre's installed equipment (left, foreground).

## My overall experience is as follows:

### Pros

- Acceptable audio quality for all student contributions
- Need only a handful of relatively light extra devices
- Microphone signal is directly routed into Zoom
- Plug and play
- Moderate cost
- Throwing around the mike adds some fun to the lecture!
- Flexibility: Several settings are possible, like two throw-around mics or two teacher mics.
- Consistency: The same equipment for all lecture rooms!
- Eduroam WiFi connection proved to be sufficient.
- Obsbot camera provides high quality video, including transmission of blackboard writing

### Cons / limits

- Students often need to be reminded that they need to wait for the mike to arrive before they can speak. (if only the throw-around mic is used)
- Quick reactions from other students or fast dialogues between students cannot be transmitted.
- Wireless mic needs recharging after 3-4 hours of operation (simply via USB-C cable).
- Obsbot camera gesture control fails from time to time, some extra practice and sometimes even a reboot are needed!
- The Zoom audio input filters are helpful but not optimal, so that listening to the filtered voices is tiring after some time, and turning the filter off keeps a slightly noisy signal.

### Troubleshooting

- *The Rode Wireless receiver is not recognized by my laptop!* Happened to me at first, but simply turning the USB-C plug of the laptop connection by 180° solved the problem.
- *The Rode Wireless signal is gone!* Maybe because the receiver crashed. That caused some trouble during the first weeks of use, but a simple 'switch it off and on again' helps, though it's annoying when it occurs.
- *My laptop died!* The mic and Zoom draw a lot of power, so always connect the laptop to the charger during the zoom sessions!
- *No video signal on the projector!* HDMI connectors tend to wear out quickly, and only cables of high quality should be used.
- *The Obsbot webcam does not follow me anymore!* Try again to focus the camera on you (see gesture control manual: raise your hand next to your head, spread the fingers apart, and camera will re-focus on your head), if that does not help, turn the camera's head down (privacy position) and up again after a few seconds!

## The full solution, more hardware and new software needed

This solution involves cable microphones with USB signal, all mixed together with the free software Open Broadcasting System (OBS) and transferred to Zoom via a virtual audio cable (VAC). The whole setup weighs around ten kilos (including the laptop) and is carried around through the city in a suitcase.

### The toolbox

Next to the equipment shown in figs. 3 or 4, the full toolbox involves a number of MXL AC-404 or MXL AC-44 directional microphones with USB connection (here: five) and the connecting USB cables (big pile in the center of Fig. 5), which cost another 400-500 EUR all together.



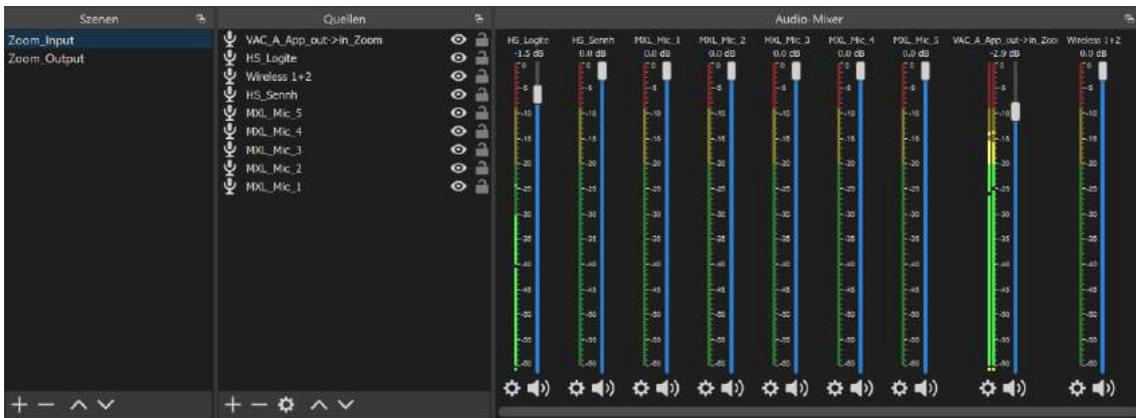
**Figure 5:** Components of the full setup. Next to the equipment shown in fig. 3, the full toolbox involves a number of MXL AC-404 or MXL AC-44 (here: five, front row) and the connecting USB cables and USB extensions (big pile in the center). Instead of the Logitech device and the external speakers, the Obsbot Tiny Webcam and the lecture theatre's speakers can be used if available (Fig. 6).

The different audio input signals are then captured by OBS (Fig. 5), where their individual volume can be regulated, and mixed together and sent to the input of the virtual audio cable (VAC). In Zoom, one then selects the output of the VAC as microphone input (Fig. 1, here, 'CABLE Output' must be ticked off).

Figure 6 shows an alternative but functionally equivalent setup with the Obsbot Tiny webcam and an HDMI cable as audio input.



**Figure 6:** Components of the full setup, alternative to Fig. 5. Next to the equipment shown in fig. 4, the full toolbox involves a number of MXL AC-404 or MXL AC-44 (here: five, center) and the connecting USB cables and USB extensions (big pile, foreground, left). The Zoom audio output is send to the lecture theatre’s speakers via the HDMI cable (right).



**Figure 7:** The Zoom input scene in OBS. For installation and configuration, see the first four minutes of the very helpful tutorial in ref. [5].

### The additional hardware components include:

- ➔ 3-5 pieces of the USB directional microphones MXL AC-404 (or the newer and lighter MXL AC-44): [https://www.thomann.de/de/mxl\\_ac\\_404.htm](https://www.thomann.de/de/mxl_ac_404.htm) (for 70-130 EUR, also available elsewhere, of course). Those are high quality professional mics that are auto-installed and recognized and come with a 1.5 m USB cable.

The MXL AC-44 have a pickup range of around 5 meters, they record voices that speak in front of them. Hence, with four of these mics, you can cover an area in the lecture hall of ca. 10 x 10 m.

- ➔ X pieces of a 5 m USB extension, depending on the size of the room. The USB extension must be high quality, best choose USB 3.0 cables with double shielding, like this one, of which I ordered six:

[https://www.amazon.de/dp/B07NSMH6RP/ref=pe\\_27091401\\_487027711\\_TE\\_SCE\\_dp\\_1](https://www.amazon.de/dp/B07NSMH6RP/ref=pe_27091401_487027711_TE_SCE_dp_1)

We managed to connect up to 3 (!) of this particular cable in series, which gives you a 15 m range for your microphone to deploy.

Other cables, esp. a 10 m USB 2.0 extension, did not work!

- ➔ 1 x USB Hub 7-fold or more with own power supply and status LED, like this one:

[https://www.amazon.de/gp/product/B00NM6BXKA/ref=ppx\\_yo\\_dt\\_b\\_asin\\_title\\_o03\\_s01?ie=UTF8&psc=1](https://www.amazon.de/gp/product/B00NM6BXKA/ref=ppx_yo_dt_b_asin_title_o03_s01?ie=UTF8&psc=1)

**On the software side**, the following installation and configuration is necessary on the machine where the Zoom meeting will run:

- ➔ Install OBS Studio with Audio Monitor PlugIn:

<https://obsproject.com/de>

<https://obsproject.com/forum/resources/audio-monitor.1186/>

- ➔ Get and install this Virtual Audio Cable:

<https://vb-audio.com/Cable/index.htm>

(Base and free version (top of homepage) is sufficient for this purpose!)

- ➔ Follow this great tutorial on OBS and the virtual audio cable: <https://www.youtube.com/watch?v=GIRwKhpLOIg> [same as ref. 5].

For our purposes, the first four minutes of this tutorial are sufficient, and it's also sufficient to just install a single (the free base version) virtual audio cable!

The result will then look something like the setup shown in Fig. 7.

Below, some specific applications of this general setup are described in more detail.

## Application 1: Mix one desktop microphone together with the wireless throw-around microphone

This setting has become the standard setup for my lectures without blackboard use.

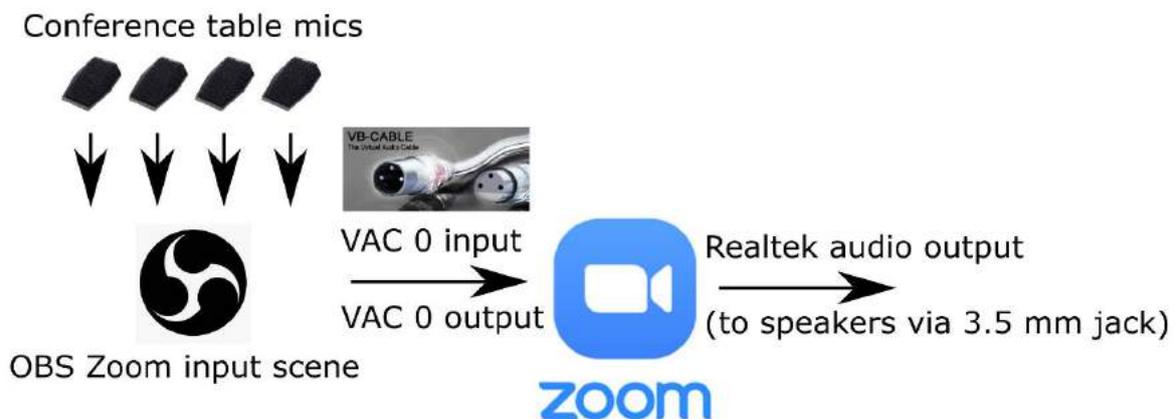


**Figure 8:** Setup (hardware and sound settings) for application 1: Mix one desktop microphone together with the wireless throw-around microphone.

The throw-around mic is passed around in the audience for questions and comments, and I have the MXL mic with the high quality sound in front of me. Both signals are mixed together in OBS. Using the other Rode Wireless GO II mic instead of the MXL will do a similar job, of course, and you don't need to worry about new software in that case.

## Application 2: Mix several desktop microphones together

This is the standard setup for group meetings and small seminars, as it closely resembles the online team meeting where a number of high quality microphones placed on the meeting table record the voices of all on-site participants, without discriminating those sitting further down the table and without waiting time for a wireless mic to arrive. This setup works quite well for our group meetings!



**Figure 9:** Setup (hardware and sound settings) for application 2: Mix the signal of several desktop microphones together.

### **Application 3: Mix a number of desktop microphones together with the wireless throw-around microphone**

Works well for panel discussions or doctoral defenses, where a small group of on-site participants talks a lot and a larger group (the audience) talks only a little.



**Figure 10:** Setup (hardware and sound settings) for application 3: Mix a number of desktop microphones together with the wireless throw-around microphone (plus additional host microphone).

We successfully used this setup for a ‘hybrid’ seminar. The critical part, i.e., the recording of the voices of the participants present in the room was of acceptable but not excellent quality: rather echo-ish and dark voices but no noise with Zoom audio filter on and very clear but rather quiet voices with some slightly disturbing general white noise on all signals without the Zoom audio filter on. Both versions are acceptable but tiring to listen to, especially for longer sessions. The main option for improvement seems to lie in a better fine-tuning of the Zoom audio input filter.

## Summary

**My overall experience is as follows:**

### Pros

- Acceptable audio quality for all student contributions
- Very flexible setup!
- Several students in the classroom can speak at the same time. Quick reactions from other students or fast dialogues between students are transmitted.
- Very good noise cancellation
- Moderate extra cost of 80-130 EUR per mike + USB extension cable
- Consistency: The same equipment for all lecture rooms! The fact that one always works with the same equipment, irrespective of the location, is a crucial advantage over fixed solutions. Troubleshooting is relatively easy with equipment that one frequently works with.
- Cable-based mics need no recharging, unlimited continuous operation time.
- Eduroam WiFi connection proved to be sufficient.

### Cons / limits

- Lots of cables! Arrangement of seats and tables (if any) needs to allow for that.
- Extra software needed.
- Extra setup and dismantling time needed.
- Cables and mics add another 3-4 kg to the weight of the equipment
- The Zoom audio input filters are helpful but not optimal, so that listening to the filtered voices is tiring after some time, and turning the filter off keeps a slightly noisy signal.

### Troubleshooting (see also the troubleshooting section of the previous chapter!)

- *The MXL mic is not recognized by my laptop!* Try out different USB extension cables. First, use only the one shipped along with the mike.
- *When I fade or mute the mic signal on the OBS scene, it has no effect on the outgoing signal!* In the 'Filter' setting for every single microphone, activate 'volume linked to source volume' and for the Mute option: 'linked to source muting'.

**In most teaching situations** (except for the master thesis student seminar), I use the simpler solutions (base case with the Rode Wireless only or application 1 with 1 desktop cable mic), since they are sufficient for the level of student interaction in the different classes.

## More cool stuff

Here, some additional options to enrich hybrid synchronous settings are described.

### (1) Breakout sessions for discussion among students during a lecture

Works well and is quite effective in getting the students to reflect and discuss! Simply send the online participants into breakout rooms on Zoom for a few minutes, and let the classroom students discuss in small groups. Then, all reconvene and exchange their findings. I always post the session topic/question into the Zoom chat and write it on the blackboard to have this point clear.

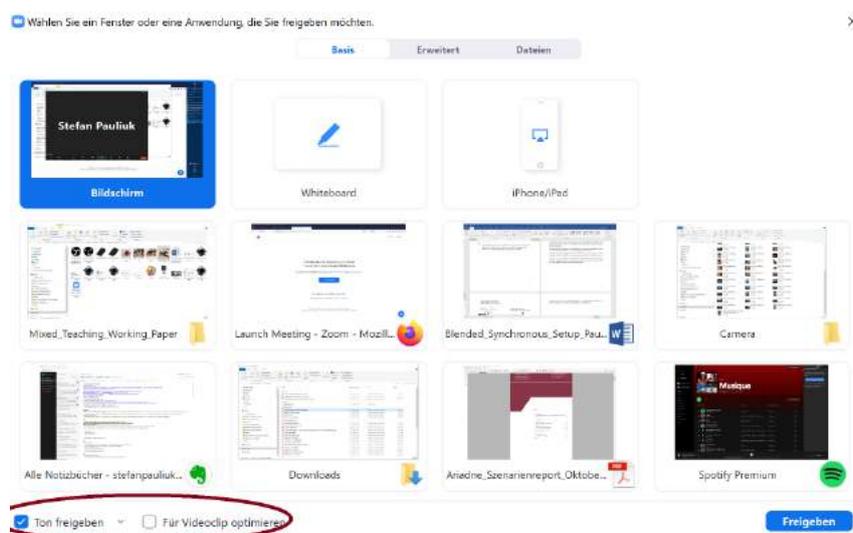
### (2) Playing (YouTube) videos or other sound during a blended synchronous session

For playing a video during a Zoom meeting so that both sides (classroom and online participants) can *see and hear* it, one needs to

- Change the Windows screen sharing settings so that the application that plays the video appears on the lecture hall's video projector.
- In the Zoom meeting, screen-share this application or the screen where the video is played.
- In Zoom's screen-sharing-dialogue, tick off the box that says 'share audio signal' or 'Ton freigeben'. Or, selecting 'optimize for video clip', which automatically enables the sharing of the audio signal (see lower left corner in Fig. 11 below). That's it!

See also this short tutorial on the standard way of sharing video with audio:

<https://www.youtube.com/watch?v=38ntUvKSkcY>



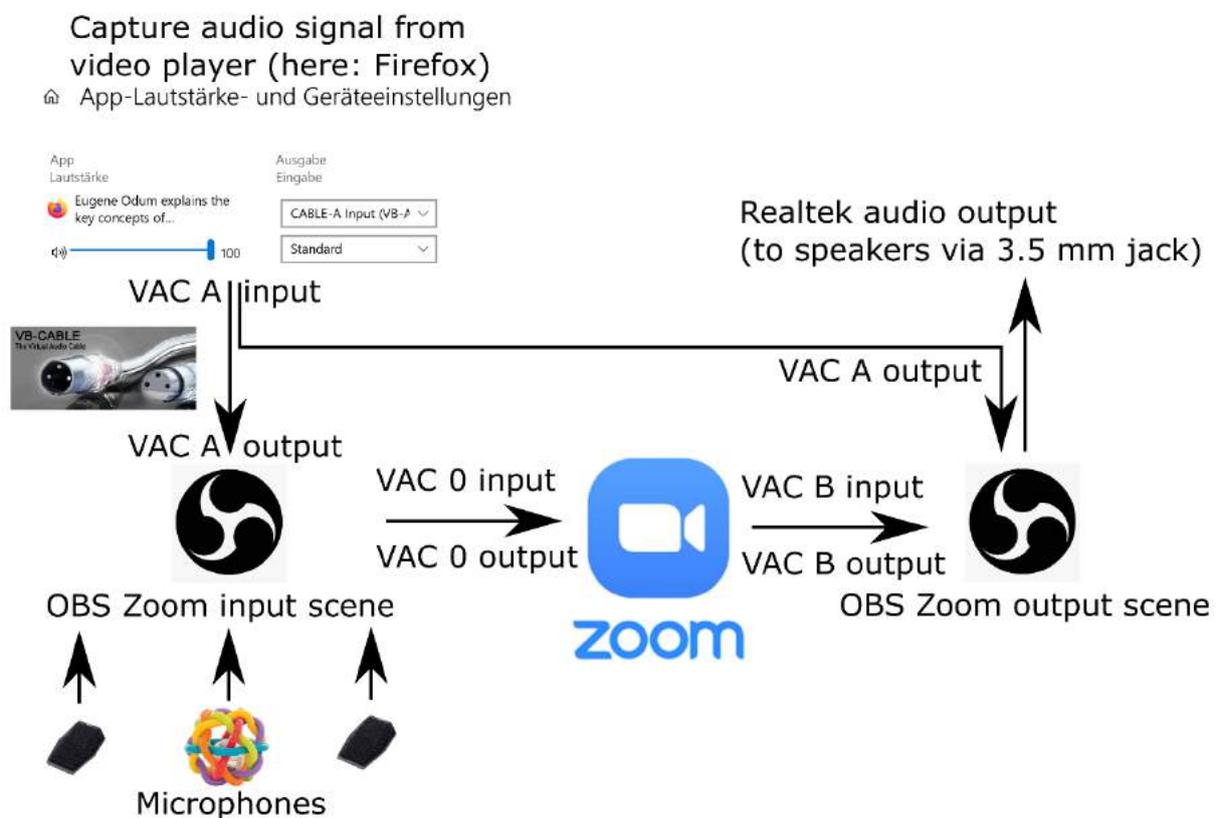
**Figure 11:** When screen-sharing a video in Zoom, tick off the box that says 'share audio signal' or 'Ton freigeben', so that the audio signal from the application that plays the video (like the web browser) is captured by Zoom and sent out along with the video signal.

### (3) Playing any sound during a blended synchronous session

There is, of course, also a more complicated solution to the audio signal sharing, involving a total of three VACs. It can be used, for example, to broadcast some music into a Zoom meeting while other content is being video-shared. This is crucial if you want the audio to be heard by both the classroom and the online participants!

By default, the Youtube video sound (or the sound of any other app like Spotify) is either available on the desktop only and thus not in Zoom, or it is sent to Zoom but then not available on the desktop anymore.

Figure 12 shows a setup where two additional virtual audio cables (VAC A and B in addition to VAC 0) are used to a) capture the desktop sound and send it to Zoom via VAC A and b) mix the same video sound together with the Zoom output for speaker output in the classroom via VAC B.



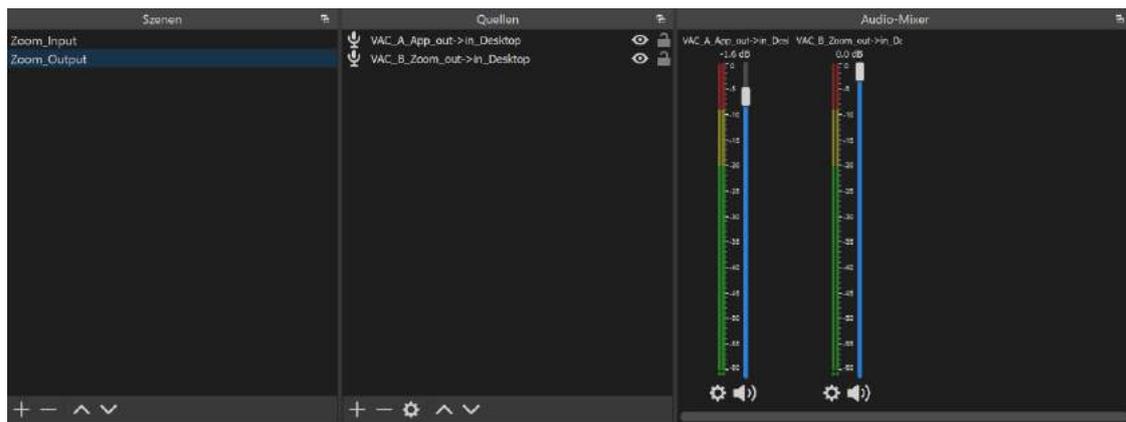
**Figure 12:** Setup (hardware and sound settings) for playing any sound during a blended synchronous session, using three virtual audio cables to exchange sound between different applications. This setup requires you to change the audio settings at three different places. In Windows (route Browser or music player audio to VAC A), in OBS (create the input and output scenes, send overall audio output to Realtek/audio jack or to the speakers via the HDMI audio output), and in Zoom (select VAC 0 as input, VAC B as output, and switch off input audio filter when streaming music (Fig. 14)).

This setting requires two scenes in OBS, one to mix all Zoom input audio source together and one to mix the Zoom output (all sounds that come from the other Zoom participants) together with the local sound to be sent to the lecture hall speakers. To set it up, just check the tutorial in ref. [5] and create another scene with a configuration following Figs. 7, 12, and 13.

This setup requires two additional VACs, available via ref. [6], for which a small donation is necessary.

The Windows audio settings can be opened by right-clicking on the speaker icon on the Windows task list, then scroll down to 'extended settings' or so and select 'App-specific settings'.

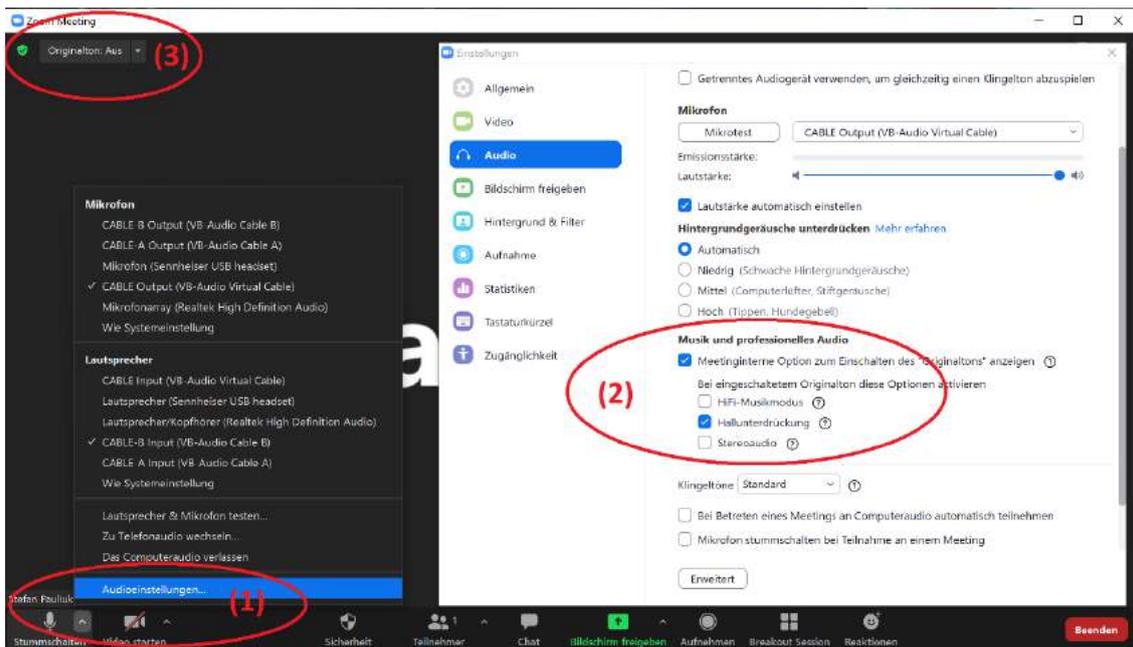
In Fig. 12, the Zoom audio output is mixed together with VAC A output (the music from the different apps) and then sent to the Realtek audio driver, which sends it to the 3.5 mm audio jack. The combined audio output of the OBS output scene can also be send to the HDMI audio output to be put on the speakers installed in the lecture theatre.



**Figure 13:** OBS Zoom output scene to mix the Zoom output (all sounds that come from the other Zoom participants) together with the local sound to be send to the lecture hall speakers.

By default, Zoom audio settings include filtering to get rid of dogs barking in the background, for example. But you don't want your music input to be distorted by Zoom's voice filters! Luckily, Zoom allows you to turn them off (Fig. 14). First, open the audio settings dialogue of Zoom by clicking on the arrow on the right side of the microphone symbol in the meeting, then select 'audio settings' (Fig. 14, step 1). Then, under 'music and professional audio', select the first option 'show 'professional audio' button in meeting' (or so, step 2 in Fig. 14). This will then show the 'original audio' button in each Zoom meeting on the upper left corner (Fig. 14, step 3). Here, you need to turn on the original sound each time the music input is activated. If you are in screen sharing mode, this button will not be visible, but you can find this option in the menu as you hover over it.

This setup turned the "Environmental Physics Christmas Lecture" into a nice online multimedia show!



**Figure 14:** How to change Zoom’s audio input filter settings. (1): Open the audio settings, (2): activate the ‘original sound on’ button, (3): activate original sound when streaming music or videos from other applications. During screensharing, this button is not visible but the option can be selected when hovering over the Zoom menu. The sub-options under step (2) will also influence performance, please try out what setting works best in your case!

### Troubleshooting (see also the troubleshooting sections of the previous chapters!)

- *How do I change the app-specific sound settings on Windows?* The Windows audio settings can be activated by right-clicking on the speaker icon on the Windows task list, then scroll down to ‘extended settings’ or so and select ‘App-specific settings’. Available for the latest versions of Windows.
- *When I fade or mute the mic signal on the OBS scene, it has no effect on the outgoing signal!* In the ‘Filter’ setting for every single microphone and other audio input, activate ‘volume linked to source volume’ and for Mute: ‘linked to source muting’.
- *When I stream music into Zoom, it sounds quite distorted to the online audience!* That is because by default, Zoom audio settings include filtering to get rid of dogs barking in the background, for example. See the paragraph above that explains how to deactivate those filters when streaming music (also Fig. 14).

#### **(4) Blackboard/Whiteboard simulation with Gaomon graphic tablet**

Blackboard and whiteboard writings can be shared with the online participants by pointing the camera to the blackboard/whiteboard.

If this is not practical (e.g., the cable is not long enough or the lighting is not good enough), the blackboard writing can be simulated with a graphics tablet (Fig. 15), which works well together with MS Whiteboard. As a side effect, the writing scenes can be saved and shared with the students after the lecture.

I bought a GAOMON S620 6,5 x 4 inch graphic table for 40 EUR and have used it in my physics lectures.

During the sessions, I then simply screen-share the whiteboard application both to the video projector in the lecture hall and to the Zoom meeting.



**Figure 15:** The graphic tablet (right) with a book of similar height (left) and gloves (front) to allow for smooth writing.

#### **Tips:**

- The tablet is ca. 8 mm high, and writing on it is much easier if a book of the same height is placed right next to it.
- Good writing and drawing with a tablet requires some practice, as does the handling of it in the Zoom meeting.
- With the driver that can be downloaded from the Gaomon home page, the function of the lower button of the writing pen can be set to 'Ctrl+Z', which means that you have an undo-button directly under your thumb.

**I hope these tips are helpful and wish you and your students a good teaching and learning experience!**

**Feedback is much appreciated!**

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