About this Guide

This guide is helping teachers to improve audio quality in Zoom for:

- dance and movement classes
- yoga and fitness classes
- theatre classes and rehearsals
- voice and music lessons
- musical performances

About the Author

Jens Wazel is a certified Soul Motion® conscious dance teacher and a photographer.

Donation

This guide helps teachers during the coronavirus crisis. If you feel moved to support my work in producing the guide, you can make a donation to paypal.me/jenswazel.

Coaching and Workshops

If you or a group of colleagues need help with your teaching situation/setup, or have any other questions, please contact me. I am happy to offer whatever assistance is most helpful: online consultations or longer workshops, 1:1 or small groups. Sliding scale.

Contact and Newsletter

For questions and comments, please email support@jenswazel.com. To stay informed about related future offerings, email news@jenswazel.com to sign up for the newsletter.
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INTRODUCTION

Zoom is a video conferencing platform that is optimized for speech. It is not designed to stream high-quality audio. Still, you can greatly improve audio quality by making changes described in this guide.

Teaching Scenarios

Many online teaching scenarios will benefit from improved audio quality, for example:

<table>
<thead>
<tr>
<th>Teaching Scenario</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Movement Classes</td>
<td>A teacher is guiding participants on a free-form movement journey, using verbal instructions and recorded music. There can be music-only periods, and periods when the teacher is talking over music. Except for a sharing period at the end of class, participants are not speaking.</td>
</tr>
<tr>
<td>Dance Choreography Classes</td>
<td>A teacher is instructing participants to learn a choreography. It is a mostly one-way presentation with at times synchronized movement to recorded music. There can be some participant sharing.</td>
</tr>
<tr>
<td>Yoga Classes</td>
<td>A teacher is guiding a yoga practice using verbal instructions. Participants are not speaking. Some teachers may use recorded music in the background, and/or share a mantra using a live musical instrument at the end of class.</td>
</tr>
<tr>
<td>Theatre Rehearsals</td>
<td>Actors are rehearsing a play. All participants speak.</td>
</tr>
<tr>
<td>Voice/Music Lessons</td>
<td>A teacher is working 1:1 with a participant. Both may share voice as well as live music over the microphone, sometimes simultaneously. They may also sing over recorded music.</td>
</tr>
<tr>
<td>Musical Performances</td>
<td>A live performer is playing an instrument and sings. They use separate microphones for voice and instrument, plugged into a mixer. Participants are not speaking.</td>
</tr>
</tbody>
</table>
Common Problems

While each teaching scenario has its own unique challenges, there are also some common problems:

| Controlling Audio Quality | When teaching offline, you have end-to-end control over the quality of your audio signal. For example, you may plug your laptop and a microphone into a high-end audio system in a studio.
|                          | When you teach online, you can only control audio quality for your local setup. The rest is up to Zoom and the quality of the participant’s setup, like their Internet connection and speakers.
|                          | Audio quality will degrade along the way, and thus it is important that you start with as good audio as possible.

| Latency                  | Latency is the delay between making a sound and having somebody else hear it. In your next Zoom meeting, do an experiment: say “1-2-3-GO”, and then have a friend on the other end say “GO” once they heard you say it. You will hear their “GO” about 1 to 1.5 seconds after yours.
|                          | That means that everything you say, do visually like a movement gesture, or music that you share will reach participants at least 1 second later, and vice versa.
|                          | **NOTE**: The amount of latency is affected by the quality of hardware and software components, the degree of compression of the audio signal (which affects audio quality), and the speed of the Internet connection, both on your end as well as for the participants.

| Voice and Recorded Music | If you give verbal instructions while also sharing recorded music, the volume of the voice must be balanced with the volume of the music, so that the music has good presence without overpowering the voice.

| Voice and Live Music     | Sharing both voice and a live instrument over the same microphone sounds horrible in Zoom. This is because Zoom is optimized for speech and by default uses noise suppression that attempts to suppress non-speech sound.

| Echo                     | If multiple participants are speaking, and if they also use external speakers to hear the meeting audio, there can be an echo loop. Zoom uses echo cancellation to address this problem.

Solutions

The purpose of this guide is to help address audio-related problems you may experience when using Zoom. Given the wide range of possible teaching scenarios, and the variety of hardware and software used by teachers, you may need to adapt the suggestions to your specific scenario and setup.

Disclaimer

Any products or services mentioned in this guide are for illustration purposes only, I am not endorsing or promoting them. Please also inform yourself about Zoom security and data privacy issues.
GENERAL SETTINGS

In a basic setup, only the “internal” or “built-in” microphone and speakers of the computer are used.

Computer Setup
You want your computer to be as fast as possible, with the strongest possible Internet connection:

- Consider using an Ethernet cable to connect your laptop directly with the router, instead of WiFi.
- If you are using WiFi, move as close as possible to your router to ensure a strong signal.
- Use an Internet Speed Test to check your connection speed, upload should ideally be > 5mbps to ensure good audio and especially video quality.
- Close all unneeded applications on your computer, including unneeded background processes (if needed use Task Manager on Windows, Force Quit or Activity Monitor on macOS.)

Zoom Meeting Settings
As the meeting host, make the following changes in your Zoom account settings under Account Management > Account Settings > Meeting before participants enter a meeting:

- Under Who can start sharing when someone else is sharing select Host Only. This prevents participants from interrupting your presentation.
- Disable Play sound when participants join or leave.

NOTE: If the meeting is organized by somebody else, it is helpful to make the teacher a co-host or even the host of the meeting.

Zoom Client Software
Zoom can be used without installing the Zoom client software on your computer. The web client has limited features though, so for our purposes you do need to install the application. Also make sure that you always have the latest version which may contain important security fixes or feature improvements.
ZOOM AUDIO SETTINGS

General Audio Settings

1. In the Zoom application, go to Settings, then Audio.
   
   **NOTE:** If you are already in a meeting, you can also access Audio Settings by clicking `^` next to the microphone symbol in the lower left corner.

2. Select the following options:

   **Speaker**
   
   - a) **Select Same as System**
   - b) **Volume = 100%**

   ![Speaker Settings](image)

   This is the how you hear sound coming from Zoom, e.g. the voices of participants, as well as computer sound you share.

   **Same as System** means that Zoom uses the output device that is currently selected in your system (see *System Audio Devices* in the *Appendix*.)

   **Microphone**
   
   - a) **Select Same as System**
   - b) **Volume = 90%**
   - c) **Unselect Automatically adjust volume**

   ![Microphone Settings](image)

   **Same as System** means that Zoom uses the input device that is currently selected in your system (see *System Audio Devices* in the *Appendix*.)

   **Automatically adjust volume** boosts or reduces the microphone signal if Zoom’s algorithms think that it is necessary. Unselect the option to have full control over your microphone volume.
Advanced Audio Settings

1. In Zoom Audio Settings, click **Advanced**.

There are 4 settings:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show in-meeting option to “Enable Original Sound” from microphone</td>
<td>When checked, the <strong>Turn on Original Sound</strong> option appears in the meeting, which will turn off audio enhancements such as echo cancellation and noise suppression.</td>
</tr>
<tr>
<td>Suppress Persistent Background Noise</td>
<td>Continuously suppresses background noise, such as fans and air conditioning.</td>
</tr>
<tr>
<td>Suppress Intermittent Background Noise</td>
<td>Suppresses intermittent background noise such as keyboard sounds.</td>
</tr>
<tr>
<td>Echo Cancellation</td>
<td>This feature can only be turned off by turning on “original sound”.</td>
</tr>
</tbody>
</table>

**NOTE:** These settings only apply to the microphone, they do **not** affect computer sound you are sharing.

2. Choose settings for your scenario:

**Voice Only**

If you are only using the microphone for voice, use default settings:

- **Show in-meeting option to “Enable Original Sound” from microphone**
- **Audio Processing**
  - **Suppress Persistent Background Noise**
  - **Suppress Intermittent Background Noise**
  - **Echo cancellation**

**Voice and Live Music**

If you are also sharing live music over the microphone, the noise suppression filters will try to eliminate any non-speech sounds. You need to disable them:

- **Show in-meeting option to “Enable Original Sound” from microphone**
- **Audio Processing**
  - **Suppress Persistent Background Noise**
  - **Suppress Intermittent Background Noise**
  - **Echo cancellation**

**NOTE:** You can try this yourself by clapping while you speak. When **Suppress Intermittent Background Noise** is set to **Disable**, participants can hear the clapping. When it is set to **Auto**, the clapping sound is suppressed.
SHARING RECORDED MUSIC

You can share recorded music from:

- Basic music applications like iTunes and Spotify
- DJ programs like Traktor Pro and Virtual DJ

**NOTE:** Please inform yourself about copyright laws in your country.

**NOTE:** Local music files should have a decent bitrate, between 192 and 320 kBit/s.

To start sharing recorded music:

1. In a Zoom meeting, click **Share Screen**
2. Click **Advanced**, select **Music or Computer Sound Only**
3. Click **Share**

**NOTES:**

- There is also a **Share computer sound** check box at the bottom. This only applies to the **Basic** window and is disabled on the **Advanced** window. You can ignore this box.

- Sharing computer sound means that sound from all applications on your computer are sent to Zoom participants. This includes calendar reminder sounds, etc. Turn off everything that can make a sound, except for your microphone and music application.

- On macOS, Zoom asks to install **ZoomAudioDevice** the first time you share computer sound. You can choose to decline to install **ZoomAudioDevice** if you are sharing sound only from applications like iTunes that automatically use the currently selected sound output device; it is needed for DJ programs that require you to select a specific device.
Music Application Settings

Output Device
Basic music applications send audio automatically to the output device currently selected in your system (see System Audio Devices in the Appendix), while DJ programs require to select a device.

*Traktor Pro*

---

**macOS**: select **ZoomAudioDevice**

**Advanced: Equalizer**
Music delivered over Zoom can sound tinny without much bass or warmth. You can use the equalizer in your program to improve audio quality. Test with different settings and different types of music.

*Traktor Pro*  *iTunes*

---

**Advanced: Volume Leveling**
Some applications allow to normalize volume across songs, so that the volume is consistent: songs that are quiet will be automatically adjusted up, and songs that are very loud will be automatically adjusted down. This is to avoid sudden extreme jumps in volume.

*Traktor Pro*  *iTunes*
Music Application Volume

You need to balance the music application volume with the volume of your voice on the microphone:

- Participants might be away from their computers, for example when dancing in a movement class. They will likely adjust their speaker volume at the beginning of your class. You neither want them to have to crank up their volume too high, which will create distortion, nor have them struggle to hear.
- There may be periods when you talk over the music, and other periods when you play music without verbal instructions. Pick one music application volume setting for each period. You want your verbal instructions to be clear and audible while also allowing participants to “feel” the music.
- The only way to know which exact volume levels to use is to try it out. Since microphone and music signals are sent to Zoom separately, you are not able to hear the mix of microphone and music yourself. One workaround is to call into a Zoom test meeting with your phone. The better way is to ask a friend to join a meeting and give you feedback.

To set volume levels for your music application:

<table>
<thead>
<tr>
<th>Speaker volume</th>
<th>Have your friend set their speaker volume to 50% if they use an external speaker, or 70% if they use an internal laptop speaker (so they have room to lower or increase the volume.) If you are teaching a movement class, ask them to stand 6 feet away from their computer.</th>
</tr>
</thead>
</table>
| Music-only       | Determine volume for music-only period:                                                                                           
|                  | a) Set music application volume to 90%.                                                                                               
|                  | b) Play a loud piece of music.                                                                                                       
|                  | c) Check if that is “loud enough” or too loud. Adjust your (or your friend’s) volume as needed.                                         
|                  | **NOTE:** DJ programs may have multiple volume settings: per deck and Master. It is best to set Master gain to +/- 0dB and only adjust with the deck slider.                                               
|                  | **NOTE:** We set system volume to 100% in Zoom Audio Settings. If that is too loud at 90% application music volume, you can reduce your system volume.                                                   |
| Talking          | Determine volume for talking period:                                                                                                 
|                  | a) Set music application volume to 50 or 70%.                                                                                          
|                  | b) Play a soft piece of music.                                                                                                        
|                  | c) Speak into the microphone. Check if your friend can clearly hear your voice over the music. If not, lower your music volume until they can. Then, stop talking and check if the music level is still enough to make your friend want to move. If it is too quiet, increase the music volume, then try talking again. Try different pieces of music with different dynamics that you would talk over, e.g. soft piano vs. a beat, until you feel there is a good balance between the volume of the music and the microphone. 
|                  | **NOTE:** If your microphone signal is very weak, and you cannot reduce your music volume enough in a DJ program, try reducing the Master gain to -10dB.                                                                              |
DURING THE ZOOM MEETING

Here are some important issues to consider during a meeting:

| Mute All | If your teaching scenario does not require participants to speak during your presentation, you should mute them. There may be a period of sharing as participants arrive, during which participants should be unmuted.

Once you start teaching, click **Mute All**.

**NOTE:** If the teacher is not the host of the meeting, and the host clicks **Mute All**, the teacher will be muted as well, so make sure to **Unmute** the teacher.

**NOTE:** If you share computer sound, and an unmuted participant talks, the music will temporarily be reduced in volume for all participants. |
|---|---|
| Mute Microphone | It is good practice to mute your microphone during longer passages when you are not planning to speak. This avoids the microphone picking up breathing or other environmental sounds.

**NOTE:** Muting your microphone will **not** mute computer sound you share. |
| Sharing Recorded Music | You identified two distinct volume settings for typical class periods: *music-only* and *talking*. Only change from one setting to the other when you switch from one (longer) period to another.

To share a verbal instruction in the middle of a *music-only* period:

1. Change music volume to *talking*
2. Unmute your microphone, do your share
3. Change music volume to *music-only*, mute your microphone |
| Music Application vs System Volume | Since we have **Speaker** set to **Same As System** in Zoom, you can change the volume of what you hear either in Zoom or in your system:

- **Windows**: the volume of computer sound you are sharing is **only** controlled by the music application, **not** by the volume of your speakers. This way, you can change the volume at which you hear the music without affecting the level of music you are sharing.

- **macOS**: both the volume in your music application and your system volume affect the volume you hear through your speakers **and** the volume of computer sound you share.

  **NOTE:** If **ZoomAudioDevice** is installed, Zoom automatically switches the system output to that device when you share, and switches back to the previous device when you stop sharing. If you are using a DJ program with the output set to **ZoomAudioDevice**, you could go to the menu bar and change the current output device to another speaker. This does not work when using music applications like iTunes. |
CHECKLIST

General
• Ensure fast Internet connection
• Close unneeded applications
• Turn off processes that may make sounds

Voice
Basic Audio Settings:
• **Speaker**: Same as System + volume at **100%**
• **Microphone**: Same as System + volume at **90%**
• Unselect **Automatically adjust volume**

Mute:
• **Mute All** participants if needed, make sure you are not muted
• Mute yourself if not speaking for a longer period

Recorded Music
1. Set up music application
2. Pick two settings for music **application audio volume**:
   • **music-only**: 90% (test to determine)
   • **talking**: 50-70% (test to determine)
3. Share Computer Sound

Live Music
Advanced Audio Settings:
• Disable **Suppress Persistent Background Noise**
• Disable **Suppress Intermittent Background Noise**
IMPROVING THE SETUP

External Speakers/Headphones
External speakers or headphones will give you better audio quality for listening to music or to hear other participants. They also allow you a greater range for physical movement.

Setup
1. Attach and install external speaker or headphone.
2. In Zoom Audio Settings, select the external speaker for Speaker.
3. Depending on the power of your external speaker, you may need to reduce playback volume from 100% to maybe 70%.
4. In Windows, change the output device in your DJ program to point to the external speaker. In macOS, leave ZoomAudioDevice as the output device.

Notes
• If you are using speakers, like a Bluetooth box or a stereo system via a USB sound card, place them so you can easily hear the music in the location where you will spend most of your time during class.
• Do not place your speaker too close to or directly facing your microphone, as the mic might pick up extra sound from the speaker, possibly creating an echo (this is especially an issue with internal computer speakers which are by design very close to the internal microphone.) You also do not want the external speaker to overpower your microphone.
• Headphones have the advantage that there is no sound pickup. On the other hand, they also remove you more from the spatial experience, and it is not as easy to hear yourself.

NOTE: If you have a Bluetooth headset with an integrated microphone, it uses a low quality “hands-free” codec when the microphone is active. You can set the device to use a higher quality codec only after you select another microphone as the input device (this does not work on phones or tablets.) This also applies to participants who would listen to your audio with greatly reduced sound quality, so it is best to discourage them from using Bluetooth headsets with built-in microphones.
External Microphones
Most built-in microphones have poor audio quality. They also limit your freedom of movement away from the computer. Adding an external microphone solves both issues.

There are a variety of options:
- Headsets/earphones, wired/Bluetooth
- USB microphones
- Wireless headset microphones
- Handheld wired microphones
- Wireless lavalier microphones

Headsets
A headset is a set of headphones equipped with a microphone. They can be either wired or Bluetooth.

IMPORTANT: See above for information about Bluetooth headsets.

USB Microphones
A USB microphone is an external microphone that contains an audio interface and is connected to the computer with a USB cable.
Wireless Headset Microphones

Wireless headset microphones are worn on the head, and the microphone is positioned close to the mouth. Headset microphones are especially useful in noisy environments and/or when you move a lot, as the mic always stays the same distance from the mouth, which can also provide a warmer emotional quality.

Wireless headset systems consist of three parts:

- Microphone
- Transmitter (body pack or integrated into the head attachment)
- Receiver

In a typical studio setup, you connect the receiver to a mixer or DJ console via a ¼ inch or XLR cable. Laptops do not have these kinds of inputs, so you need to add another component to route the microphone signal from the receiver into the computer, for example:

- USB audio interface
- External mixer (discussed further below)
- External DJ controller (discussed further below)

USB Audio Interfaces

USB audio interfaces are external hardware components whose main function is to connect external sound equipment, such as microphones or guitars, to a computer.
You connect the microphone receiver with the USB audio interface using a standard ¼ inch or XLR cable, and the USB audio interface with the computer using a USB cable.

**NOTE:** USB audio interfaces typically have a knob to control the volume gain of the microphone signal passed to your computer. When testing the audio setup, you need to make sure that your signal is a) loud enough and b) not distorted. Note that the microphone volume settings in Zoom's **Audio Settings** have no effect when an audio interface is used.

**Handheld Wired Microphones**

You can also attach a handheld wired or wireless microphone to a USB audio interface.

**Wireless Lavalier Microphones**

Different than headsets where the microphone is constantly close to the mouth of the speaker, lavalier microphones are attached to clothing, and thus can pick up more ambient sound from the room as well as from the clothing or jewelry. In addition, the audio may vary in volume if the speaker is moving their head towards or away from the microphone. This can be a problem especially when speaking over music. Still, if you own a lavalier microphone, it can be a good choice, especially when combined with a wireless microphone system.
NOTE: You may need a different kind of adapter that works with 3.5mm TRS plugs, for example:

Setup
1. Attach external microphone to your computer.
2. Select the microphone in Zoom Audio Settings.
3. Adjust volume gain (test to determine).
4. Turn microphone off when not in use.

Stereo Sound
You need to specifically enable stereo sound in Zoom, otherwise your audio will be delivered in mono.
1. In Account Management > Account Settings > Meeting, enable Allow users to select stereo audio in their client settings.
2. In Zoom Audio Settings select Enable Stereo Sound.

NOTE: It does not matter whether participants have checked Enable Stereo Sound on their end. As soon as you enable it on your end, participants will hear a stereo signal.

IMPORTANT: Make sure that your microphone is either sending a stereo signal, or that you set your mic to mono in your DJ program. Otherwise, participants will hear your voice only on one side.
**External Monitor**

Using external speakers and microphones allows a greater range of movement away from the computer. It may then also be important to see the Zoom window larger than on a typical laptop screen, especially when teaching classes with dozens or hundreds of participants.

The solution is to add an external monitor to your computer, and then either use that monitor instead of the laptop screen or extend your screen to use both monitors: one for Zoom and one for a music application.

![Diagram of external monitor setup](image)

**NOTE:** The external monitor can be any device you can add through HDMI or USB-C, e.g. a big screen TV.

**External Webcam**

Even when using an external monitor, your webcam and thus your computer needs to be close to the monitor. This can be awkward when you need to operate your computer during class, e.g. make volume changes in your music application. One solution is to:

1. Place an external webcam on top of the external monitor
2. Connect the webcam to your computer with a USB extension cable (or use a wireless webcam)
3. Connect the external monitor with an HDMI extension cable

You can then place your computer anywhere in the room, depending on cable length.
Choosing a webcam
As with all external components, there is a wide variety of products available, most of them of better quality than a built-in webcam. For the purposes of teaching over Zoom, it is not necessary to get the latest 4k-enabled camera (it cannot hurt either), generally a decent HD 1080 device will suffice.

Smartphone as webcam
You can also your smartphone into a wireless webcam, for example with the “EpocCam HD” (Kinoni) app. Quality is “OK”.

**NOTE:** One idea could be to use the smartphone webcam as a second camera to provide an alternative angle. You could then switch between webcams during class.

Digital camera as webcam
You will get the absolute best video quality by turning your digital SLR or mirrorless camera into a webcam. You need a HDMI capture device for this to work, like the “Elgato Camlink”.

Setup
1. In Zoom, go to **Video Settings**
2. Select the external webcam from the list

![Camera Settings](image)

**NOTE:** There is an option **Mirror my video**. It can be important to set this consistently between you and your students when orientation is important, for example when teaching dance choreography.

Lighting
Even with the most expensive webcam, your video (or you) will not look good if your lighting is bad. While lighting for video is its own art form, you can make a big difference even with simple adjustments, like making sure that your face is not backlit.
ADVANCED AUDIO SETUP

Adding an external microphone and external speakers makes a big difference in improving audio quality. There can also be more advanced scenarios where you might want the ability to preview the mix that students hear when playing recorded music, EQ your microphone, or add other devices or sound equipment for music lessons. This can be achieved by using additional hardware and/or software.

Methods

When sharing recorded music, you have sent microphone and music signals separately, by selecting a microphone in Zoom Audio Settings and sending music by sharing computer sound. It may also be useful or necessary, for example for live music using an analog mixer, to send only a single audio signal:

<table>
<thead>
<tr>
<th>Method</th>
<th>Noise suppression*</th>
<th>Echo cancellation*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 independent signals:</td>
<td>Auto (voice-only)</td>
<td>Auto</td>
</tr>
<tr>
<td>Zoom Microphone + Share Computer Sound</td>
<td>Disable (live music)**</td>
<td></td>
</tr>
<tr>
<td>Combined microphone + music mix:</td>
<td>Disable**</td>
<td>Auto</td>
</tr>
<tr>
<td>Zoom Microphone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined microphone + music mix:</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Share Computer Sound (macOS: ZoomAudioDevice)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Audio Enhancement features only apply to the Zoom Microphone

** If music is sent over the Zoom microphone, we need to disable noise suppression

Examples

The following examples illustrate general concepts which you can adapt to your situation. There can be many other hardware and software configurations, depending on which components you may already own or want to acquire, and on the specific needs of your teaching situation.

Windows: You may have multiple audio driver choices when selecting devices. Choose one, in order of preference: ASIO, WDM, DirectSound, WASAPI, MME. Some of them may not work well with your hardware. If there is a problem, choose another driver and try again.
Example: Virtual DJ

Virtual DJ is a DJ program that allows to add a microphone as an input device and assign output devices.

<table>
<thead>
<tr>
<th>Method</th>
<th>Combined microphone + music mix through <strong>Share Computer Sound</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>Monitor mix through headphones</td>
</tr>
<tr>
<td></td>
<td>Hear your music + sound from Zoom participants through external speakers</td>
</tr>
<tr>
<td></td>
<td>EQ music</td>
</tr>
<tr>
<td></td>
<td>Record mix</td>
</tr>
<tr>
<td>Hardware</td>
<td>External microphone connected through a USB audio interface</td>
</tr>
<tr>
<td></td>
<td>Headphones connected to computer</td>
</tr>
<tr>
<td></td>
<td>External speakers</td>
</tr>
<tr>
<td>Software</td>
<td>Virtual DJ</td>
</tr>
</tbody>
</table>

**Setup**

1. Select internal speakers (headphones) as output device (see **System Audio Devices** in the **Appendix**.)
2. In Virtual DJ **Audio Settings** under **Outputs** add:
   - **master**: system output device (headphones) (mic + music mix)
   - **master**: **ZoomAudioDevice** (**macOS only**) (mic + music mix)
   - **booth**: external speakers (music only)
   - **headphone**: <another set of headphones to preview tracks>
3. In Virtual DJ **Audio Settings** under **Inputs**, click **Microphone**.
4. For **mic**, select USB audio interface (select a **mono** channel if needed for your microphone.)
5. In the main window, click **MASTER**. Set **MASTER** volume to 50%.
6. Set **MIC VOL** volume to 100%. Click **ON** under **MIC VOL**.

![Zoom Audio Settings](image)

7. Go back to **AUDIO**. Use the equalizer to improve audio quality for the music.
   
   **NOTE**: There is no EQ for the microphone.

**Zoom Audio Settings**

Select external speakers for **Speaker**. Set volume to 70%.

**NOTE**: It does not matter what is selected for **Microphone**, since we will mute it.

**Music Application Volume**

1. Set deck volume in Virtual DJ to 100% for **music-only** period.
2. Set deck volume in Virtual DJ to 50% for **talking** period.
3. Adjust microphone gain on external USB interface so that the microphone level in Virtual DJ never goes into the red (distorted) range, and that you can hear yourself over the music.

**NOTE**: When listening to the mix with headphones, there might be a slight delay for your voice. This is because of the latency of your components; the better they are, the less latency will occur.

**Zoom Meeting**

1. Mute the microphone in Zoom.
2. Share Computer Sound in Zoom.
3. Play music in Virtual DJ.
4. Set deck volume in Virtual DJ to either **music-only** or **talking** level.
5. To change the volume of your external speakers, you can use Zoom **Audio Settings**.
6. If you are not talking for a longer period, turn the microphone off in Virtual DJ under **MASTER**.
7. If you want to record your mix, go to **Settings**, then **RECORD**.

**Alternative Setup Windows**

You could also send the microphone + music mix through **Zoom Microphone**:

1. Install “VoiceMeeter Virtual Audio Cable” from vb-audio.com. Restart your computer.
2. Under Virtual DJ **Outputs**, add the following:
   - **master**: virtual cable (mic + music mix)
   - **master**: headphones (mic + music mix)
   - **booth**: external speakers (music only)
3. In Zoom **Audio Settings**, select **CABLE Output** for **Microphone**. Set volume to 100%.
4. Click **Advanced**. Select **Disable** for both **Suppress** options:
5. Do not **mute** the microphone in Zoom.
Example: Traktor Pro

Traktor Pro is a DJ program that can be paired with DJ controllers, some of which are also audio interfaces that you can plug an external microphone and headphones into.

<table>
<thead>
<tr>
<th>Method</th>
<th>Combined microphone + music mix through <strong>Share Computer Sound</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Goals</strong></td>
<td>Hear your mix + sound from Zoom participants through headphones</td>
</tr>
<tr>
<td></td>
<td>Pre-listen to tracks using second pair of headphones</td>
</tr>
<tr>
<td></td>
<td>EQ music</td>
</tr>
<tr>
<td></td>
<td>Record mix</td>
</tr>
<tr>
<td><strong>Hardware</strong></td>
<td>DJ Controller Traktor Kontrol S2</td>
</tr>
<tr>
<td></td>
<td>External microphone connected to controller</td>
</tr>
<tr>
<td></td>
<td>Headphones connected to controller</td>
</tr>
<tr>
<td></td>
<td>Headphones connected to computer</td>
</tr>
<tr>
<td><strong>Software</strong></td>
<td>Traktor Pro</td>
</tr>
</tbody>
</table>

**Setup Controller macOS**

1. Plug microphone and headphones into controller.
2. Connect controller to computer.
3. Go to Applications > Utilities > Audio Midi Setup.
4. Create an aggregate device by combining the controller with **ZoomAudioDevice**.

**NOTE**: Traktor Pro only supports a single audio device, so you need to create an aggregate device.

5. To avoid audio glitches, enable **Drift Correction** for the aggregate device and make sure the sample rate is the same for all devices in the aggregate device.

**Windows**: you can create an aggregate device by using **ASIO4ALL**. However, this is not working well with Zoom, since ASIO4ALL puts on exclusive lock on audio drivers, which are then inaccessible to Zoom.
Setup Traktor Pro

1. **Preferences:**
   - **Audio device:** set to aggregate device
   - **Output monitor:** set to headphones (built-in output)
   - **Output master:** set to aggregate device
   - **Input Deck C:** set to microphone

2. **Switch Deck C to Live Input.**

Zoom Audio Settings

Select **Built-in Output (headphones)** for **Speaker**. Set volume to 70%.

**NOTE:** It does not matter what is selected for **Microphone**, since we will mute it.

Music Application Volume

1. Set deck volume in Traktor Pro to 100% for **music-only** period.
2. Set deck volume in Traktor Pro to 50% for **talking** period.
3. Adjust microphone gain on Deck C in Traktor Pro and/or on the controller so that you can hear yourself over the music.

Zoom Meeting

1. Mute the microphone in Zoom.
2. Share Computer Sound in Zoom.
3. Play music in Traktor Pro.
4. Set deck volume to either **music-only** or **talking** level.
5. Use headphones connected to controller to pre-listen to tracks.
6. Use headphones connected to computer to listen to your mix or participants.
7. If you are not talking for a longer period, turn the microphone off.

Alternative Setup: Controller Without Microphone Input

When using a controller like the Z1 that does not have a microphone input, you can unmute the Zoom microphone and select the built-in microphone. Use **Main Volume** in Traktor Pro to adjust the mix.
Example: Software Mixer

Software audio mixer/routing applications use virtual audio devices to mix devices or applications.

| Method | Combined microphone + music mix through **Share Computer Sound**  
|        | No echo cancellation or noise suppression |
| Goals  | Monitor mix through headphones  
|        | Hear your music + sound from Zoom participants through external speakers  
|        | EQ music and microphone  
|        | Record mix |
| Hardware | External microphone connected through a USB audio interface  
|        | Headphones  
|        | External speakers |
| Software | Music application that allows to select a specific output device  
|        | **NOTE**: basic music applications like iTunes or Spotify do not support this  
|        | Software audio mixer/routing application:  
|        | o *Windows*: “VoiceMeeter Banana”  
|        | o *macOS*: “SoundDesk” (LoudLab)  
|        | **NOTE**: You can also look at audio routing applications like “Loopback” (Rogue Amoeba), “Sound Siphon” (StaticZ), or “SoundFlower” (GitHub) |

**VoiceMeeter Setup**

1. Right-click “HARDWARE INPUT 1” and rename to “Microphone”. Select external mic. Click **mono**.
2. Under “VIRTUAL INPUTS”, right-click above “VoiceMeeter VAIO” and rename to “Music”.
3. Right-click above “VoiceMeeter AUX” and rename to “Zoom”.
4. In the right-hand section, click **A1**, and select your headphones.
5. In the right-hand section, click **A2**, and select your external speakers.
6. Route inputs to outputs: “Microphone” -> **A1**, “Music” -> **A1 + A2**, “Zoom” -> **A2**
NOTE: Make sure that your internal microphone is either muted or disabled (see System Audio Devices in the Appendix.)

Equalizer
Use equalizers to improve audio quality for both the microphone and the music.

Recording
VoiceMeeter has a built-in recorder that allows to record the mix.

Right-click the recorder, select A1.
Zoom Audio Settings
Select **VoiceMeeter Aux Input** for **Speaker**. Set volume to 70%.

**NOTE:** It does not matter what is selected for **Microphone**, since we will mute it.

Music Application Setup
Open music application and change output device to a “VoiceMeeter Input” driver (not “AUX”).

*Traktor Pro*

<table>
<thead>
<tr>
<th>VoiceMeeter AUX Virtual ASIO (ASIO)</th>
<th>Audio Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>VoiceMeeter Insert Virtual ASIO (ASIO)</td>
<td>VB-Audio VoiceMeeter VAIO</td>
</tr>
<tr>
<td>VoiceMeeter Virtual ASIO (ASIO)</td>
<td>Sample Rate 44100 Hz</td>
</tr>
<tr>
<td>VB-Audio VoiceMeeter VAIO (WASAPI (Shared Mode))</td>
<td>Latency 441</td>
</tr>
<tr>
<td>Speakers (Realtek(R) Audio) (WASAPI (Shared Mode))</td>
<td></td>
</tr>
</tbody>
</table>

Music Application Volume
1. Set music application volume to 100%.
2. Set “Music” in VoiceMeeter to 0dB for **music-only** period.
3. Set “Music” in VoiceMeeter to -10dB for **talking period**.
4. Set “Microphone” in VoiceMeeter to 0dB. Adjust microphone gain on external USB interface so that the microphone level in VoiceMeeter never goes into the red (distorted) range, and that you can hear yourself over the music.

**NOTE:** When listening to the mix with headphones, there might be a slight delay for your voice. This is because of the latency of your components; the better they are, the less latency will occur.

Zoom Meeting
1. Mute the microphone in Zoom.
2. Share Computer Sound in Zoom.
3. Play music in your music application.
4. In VoiceMeeter, set “Music” volume to either **music-only** or **talking level**.
5. If you are not talking for a longer period, **Mute** the “Microphone” in VoiceMeeter.
6. If you want to record your mix, click Record.

Alternative Setup
You could also send the microphone through **Zoom Microphone** and music only via VoiceMeeter through **Share Computer Sound**. You could also add the microphone to VoiceMeeter to monitor the mix.
Example: USB Mixer
There are USB mixers that allow to plug in an external microphone and headphones.

| Method | • Combined microphone + music mix through Zoom Microphone  
|        | • Echo cancellation enabled, noise suppression disabled |
| Goals  | • Monitor mix through headphones  
|        | • Hear your music + sound from Zoom participants through external speakers  
|        | • EQ music and microphone  
|        | • Record mix |
| Hardware | • USB Mixer connected to computer  
|         | • External microphone plugged into mixer  
|         | • Headphones plugged into mixer  
|         | • External speakers connected to computer |
| Software | • Music application that allows to select a specific output device, e.g. Virtual DJ |

**NOTE:** Basic music applications like iTunes or Spotify do not support this.

Setup Mixer
1. Plug external microphone and headphones into the mixer.
2. Attach mixer to computer with USB cable.
3. Choose a routing in the mixer so that you hear a mix of microphone and music in the headphones and that the mix is also sent back to the computer. For the XENYX Q502USB mixer used in this example, “To Phones” is not pressed and “To Main Mix” is pressed.
4. Set volume for the MAIN MIX to 25%. Set volume for PHONES to 50%.
5. Use the microphone EQ on the mixer to improve the audio quality of your mic.
Setup Virtual DJ

1. Open Audio Settings in Virtual DJ.
2. Under Outputs, add the following:
   - **master**: USB mixer (mic + music mix)
   - **booth**: external speakers (music only)

3. In the main window, click **MASTER**. Set **MASTER** volume to 50%.
4. Go back to **AUDIO**. Use the equalizer to improve audio quality for the music.

Zoom Audio Settings

1. Select external speakers for **Speaker**. Set volume to 70%.
2. Select USB mixer for **Microphone**. Set volume to 90%.
3. Click **Advanced**. Select **Disable** for both **Suppress** options.

Music Application Volume

1. Set deck volume in Virtual DJ to 100% for **music-only** period.
2. Set deck volume in Virtual DJ to 50% for **talking** period.
3. Adjust microphone gain and/or volume on USB mixer so that you can hear yourself over the music.

**NOTE**: When listening to the mix with headphones, there might be a slight delay for your voice. This is because of the latency of your components; the better they are, the less latency will occur.

Zoom Meeting

1. Play music in Virtual DJ.
2. Set music application volume to either **music-only** or **talking** level.
3. To change the volume of your external speakers, you can use Zoom **Audio Settings**.
4. If you are not talking for a longer period, turn the microphone off in Virtual DJ under **MASTER**.
5. If you want to record your mix, go to **Settings**, then **RECORD**.
Example: Analog Mixer

There are analog mixers which can be connected to the computer with a USB audio interface.

| Method | • Combined microphone + music mix through Zoom Microphone  
• Echo cancellation enabled, noise suppression disabled |
| Goals | • Monitor mix through headphones  
• Hear your music through monitor speakers  
• Hear sound from Zoom participants through external speakers  
• EQ music and microphone, e.g. add reverb |
| Hardware | • Analog mixer connected with cables to USB audio interface  
• Device (computer, tablet, smartphone) plugged into mixer input  
• External microphone plugged into mixer input  
• Headphones plugged into mixer output (mic + music mix)  
• Monitor speakers plugged into mixer output (music only)  
• USB audio interface connected with computer via USB  
• External speakers connected to computer (sound from Zoom participants) |

Zoom Audio Settings
1. Select external speakers for Speaker.
2. Select USB audio interface for Microphone.
3. Click Advanced. Select Disable for both Suppress options.

Setup, Test Audio, Zoom Meeting
See Example: USB Mixer.
Streaming

Zoom is optimized for low-latency delivery of speech, not for high quality audio. The suggestions above go a long way to improve audio quality, but it is still lacking when compared to services that are optimized to stream music over the Internet.

Teachers that do not require an interactive experience during a session can share audio through a separate streaming platform. Zoom can still be used for opening and closing meetings with participants but is then used only for visuals during the session. Participants need to open two different links on their devices: one for Zoom (video) and one for the streaming service (audio.)

For example:
1. Opening circle using Zoom audio and video.
2. Mute all participants in Zoom, including the teacher.
3. Send separate audio link for the music, use Zoom to see participants.
4. Meet back in Zoom with unmuted microphones.

**NOTE:** Higher audio quality comes with higher latency: there can be a 5-30 second delay in the delivery of audio through a streaming platform. Which delay is acceptable depends on the situation, for example in a dance class you would not want more than 5 seconds delay, because you want to ensure that participants are visually still in the same song as the one you are currently playing.

On the other hand, if you watch a DJ turn a knob on a Zoom video feed to deliver a “drop”, it might not be an issue to hear the result of that action 10 seconds later.

Here are some examples of popular streaming services:
- https://livesets.com
- https://mixlr.com
- https://www.mixcloud.com
- https://obsproject.com
- https://www.twitch.tv
- https://www.rocketbroadcaster.com

**NOTE:** Please inform yourself about copyright restrictions when streaming music over the Internet.
APPENDIX
System Audio Devices

Windows
There are 3 different locations where you can select which output device the system is currently using:
1. Windows Settings > System > Sound > Chose your output device
2. Speaker symbol in taskbar
3. Control Panel > Hardware and Sound > Sound > Playback

There are 2 different locations where you can select which input device the system is currently using:
1. Windows Settings > System > Sound > Chose your input device
2. Control Panel > Hardware and Sound > Sound > Recording

NOTES:
• In Control Panel, you can change the currently used device by selecting it and clicking Set As Default.
• You can also double-click the default device to display Properties, such as volume settings or microphone gain under Levels.

macOS
There are 2 different locations where you can select which output device the system is currently using:
1. System Preferences > Sound > Output
2. Speaker symbol in menu bar

To select which input device the system is currently using:
1. Go to System Preferences > Sound > Input

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