

STEMBOT

Chatbot creation for STEM learning

A step-by-step guide to the STEMbot approach

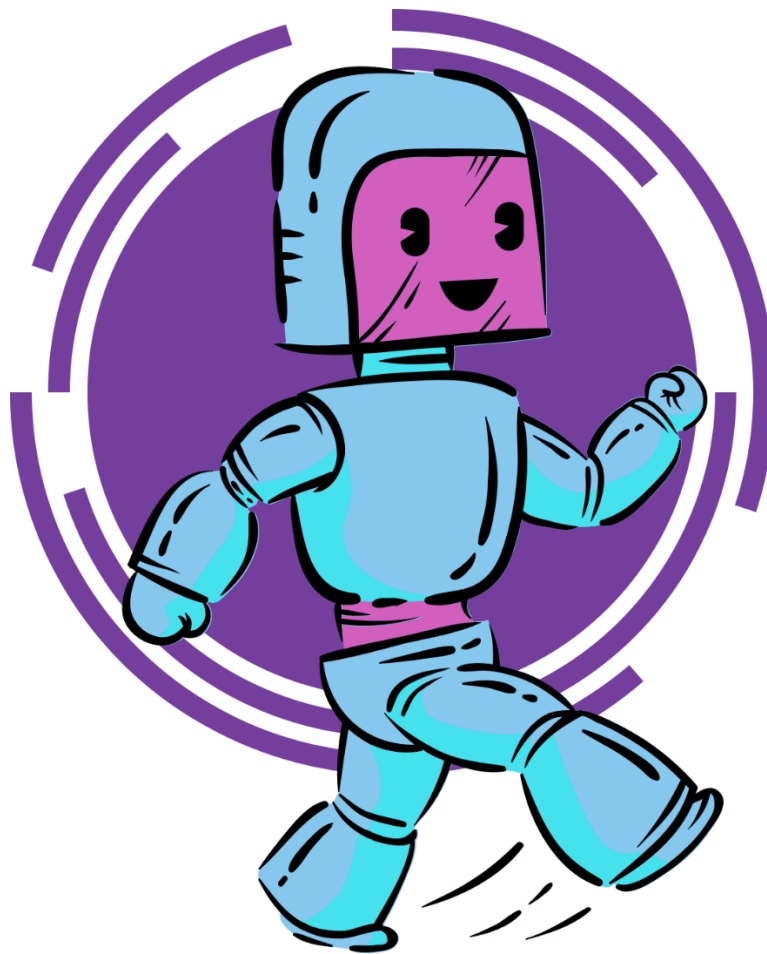


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Introduction

Firstly, science, technology, engineering, and maths (STEM) are key areas that need skilled workers now and in the future.

As technology advances and the world becomes more complex, STEM becomes even more important to students' success. Indeed, these subjects play a crucial role in shaping a better, more innovative, sustainable, and equitable future. We are therefore convinced of the value of helping all students to progress in these subjects.

On the other hand, artificial intelligence is a major innovation that is changing almost every aspect of the world, and education is no exception.

Let's see how it can be useful in STEM learning!

Why a chatbot for STEM learning?



Figure 1 - Chatbots in education. Photo: Istock/Alina Kvaratskhelia

A chatbot is a computer program designed to simulate a human conversation with users via instant messaging interfaces, websites, mobile applications or other communication channels. These programs generally use artificial intelligence (AI) and natural language processing (NLP) to understand users' questions and answers and provide relevant responses.

Using a chatbot to learn science offers many possibilities. First and foremost, it's a fun way of approaching concepts that may at first seem complex to students. It is difficult for students to study scientific concepts, particularly mathematical ones, because they are too abstract in lessons, and using an innovative, digital and original medium can be a source of fun and, therefore, of motivation.

The integration of chatbots into STEM education represents an innovative and forward-thinking approach to teaching and learning. It prepares learners for the changing technological landscape and encourages them to embrace new educational technologies.

In addition, the chatbot is a support that is accessible to all and promotes inclusion. Students will be able to chat with it at any time and in any place, whether at school or at home. The chatbot makes learning more personalised and autonomous, as students can ask questions and choose the subjects they want to work on.

Finally, the chatbot can be used for ongoing evaluation of students' skills; in fact, a chatbot can be used for regular formative evaluations throughout the learning process. This allows students to track their progress and teachers to quickly identify gaps and needs for improvement. The chatbot can also provide detailed feedback on the students' answers, explaining any mistakes made and suggesting areas for improvement. This enables students to better understand their mistakes and improve.

A chatbot for STEM learning thus brings a multitude of benefits, from personalised learning experiences and increased engagement to cost-effectiveness and inclusivity. By harnessing the potential of chatbots, we can usher in a new era of interactive and effective STEM education, empowering learners to thrive in the digital age.

Why a chatbot with videos of STEM experiments?



Figure 2 - Photo: Freepik stock image

Using videos of science experimentation for STEM learning is a highly effective and beneficial educational approach. There are many advantages: visualisation of abstract concepts through real experiments, immediate student engagement and interest - videos of scientific experiments are often entertaining and captivating, accessibility to experiences that are otherwise inaccessible because they are too expensive or too dangerous, accessible to everyone and anywhere (from the classroom to the home)...

By using videos of science experiments, teachers can make STEM learning more lively and stimulating, encouraging a better understanding of concepts and a greater passion for science and maths among students.

A chatbot integrated into these videos offers unique advantages that improve the learning process and captivate students even more.

By using a chatbot to accompany videos of scientific experiments, students become involved in their own learning. They use their senses to learn: they look, they hear, they talk, they touch... It's an interactive, accessible experience that can help them develop their understanding of science and stimulate their interest in the subject.

This media combination revolutionises the learning experience by providing content that is interactive, engaging, and accessible to all. It enables learners to develop a deeper understanding of scientific principles, encourages critical thinking and inspires a lifelong curiosity about STEM subjects. By exploiting the power of video experiments, chatbots become transformative tools in the quest for knowledge and scientific exploration.

Chapter 1: How to design a step-by-step experiment

What is the scientific method?

The scientific method is a systematic process used by scientists to acquire knowledge and understand the world around us. It is based on rigorous observation, experimentation, and analysis in order to formulate scientific hypotheses and theories. It is very important to talk to your students about this method so that they understand how scientific research works.

Here are the main stages in the scientific method, with an experiment on the concept of dissolution as an example:

- **Observation: Observe something happening in the world.**

The process begins with careful observation of a natural phenomenon or a specific problem. This stage involves collecting facts and identifying patterns or relationships that might be interesting to study.

This part of the experiment is important for stimulating the students' curiosity about their environment!



In a dissolution experiment, the observation might be as follows:

Some solid materials dissolve in water.

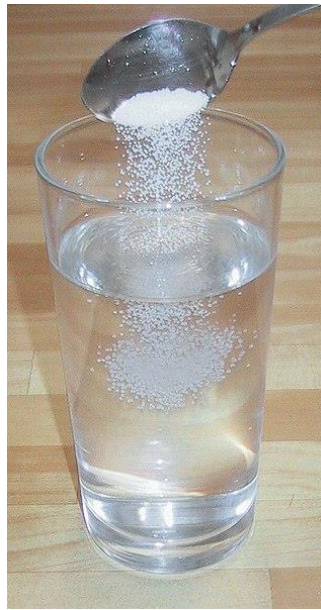


Figure 3 - Photo Wikimedia commons

- **Questioning: Ask a question based on the observation**

There is no experiment without a question! Based on the observations, a question is formulated.

If an observation makes students curious, questions make them increasingly curious. Questions encourage students to analyse their environment. It's a good idea to let them ask their own questions, so the more open-ended the observation, the better!

For a student to try to solve a problem, it has to make sense to them. They have to have participated as much as possible in its emergence; in a word, the problem has to become their own and they have to want to solve it.



For our example of an experiment on dissolution, we could ask a simple question such as:

Which solids dissolve in water?

- **Research and literature review: researching what already exists**

Existing studies and research on the subject are examined to familiarise with the knowledge already available.

Rather than starting from zero to try and answer our question, we use the library and Internet research to help us find the best way of doing things and ensure that we don't repeat the mistakes of the past.

- **Hypothesis: Formulate a theory about the reasons for the observed event.**

A hypothesis is a proposition put forward as a possible explanation for an observed phenomenon, and it must be testable.

It attempts to answer your question with an explanation that can be tested. A good hypothesis then allows you to make a prediction: "If ____ [I do this] ____, then ____ [this] ____ will happen."

This is where you challenge your students to come up with an answer to the question. Ask them to finish the sentence, "I think that...". The hypothesis stage of the scientific method nurtures students' reasoning and problem-solving skills.

What hypotheses can we formulate for our experiment?

Perhaps:



I think that... sand does not dissolve.

I think that... sugar dissolves.

I think that... coffee dissolves.

- **Experimentation: Test the hypothesis by conducting an experiment**

To test the hypothesis, experiments need to be designed and carried out in a controlled manner. This involves manipulating variables and observing the results to obtain data.



A method for the dissolution experiment could be:

Add a solid material to water (hot or cold) to see if it dissolves.

The experiment is used to check whether their prediction is correct and, therefore, whether their hypothesis is confirmed. This is when the students get to work and carry out the experiment!

They have to propose an experiment, write up an experimental protocol to check whether or not their hypothesis is correct and make a list of the equipment needed (often accompanied by a drawing).

- Write an experimental protocol: list the actions to be carried out
- Draw a diagram of the experiment: you may need to draw several diagrams to describe your experiment. The drawings must be clean, labelled and drawn up with a ruler and pencil.

- **Data collection: Analyse the data and arrive at a conclusion**

Data is collected and recorded systematically during the experiment. Statistical methods can be used to analyse the data and draw meaningful conclusions.

It is useful to prepare a data table beforehand. All you have to do is insert the values of the different variables when you collect them.

- Analysis and interpretation

The results of the experiment are analysed to determine whether they support or refute the hypothesis formulated at the outset. This analysis enables evidence-based scientific conclusions to be made.



The students must explain the aim of their experiment in the following terms:

"If in this experiment I observe that... then..."

- Formulation of conclusions

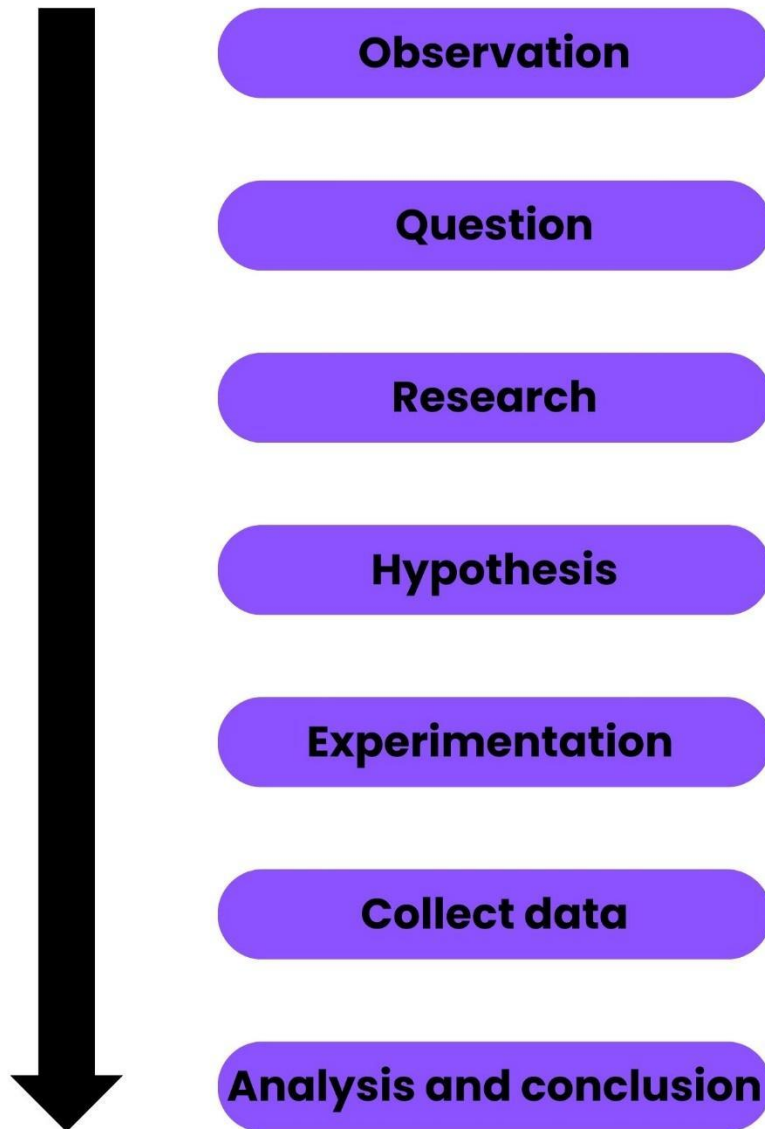
The conclusions are based on the analysis of the data and the interpretation. The students must answer the initial question and validate or not their hypothesis on the basis of the observations made, in the form: "I deduce that...".



For the dissolution experiment, results such as:

My hypothesis was correct. The experiment taught me that sugar dissolves just as well in hot water as in cold water. But it dissolves more quickly in hot water...

You will find below a framework that allows you to find these different steps:



These steps of the scientific process are essential, and they should set the pattern of your video experiment: remember to go through every step of the process in your final video.

How to "invent" or "create" an experiment, with the end goal of making an engaging video out of it: Example based on an experiment from the STEMbot project

Creating an engaging video based on an experiment can be a fun and educational project. Here's a step-by-step guide on how to invent or create an experiment to make an engaging video:

- 1) Choose a subject

Start by choosing a subject that interests you and has the potential to captivate your students. It could be an experiment in physics, chemistry, biology, mathematics, etc. It all depends on the subject you teach or want to study as a cross-curricular subject. You should also think about the duration of the experiment, the desired level and the target audience.



For our example linked to the STEMbot project, let's take the following theme:

Physics and notions of density. The experiment lasts about 10 minutes, the level is easy, and the target audience is students aged 14 to 18.

- 2) Research and brainstorm

Do some in-depth research on your chosen subject (in specialist book or on the internet) to understand the concepts and existing experiences related to it. Explore different angles, possibilities, and creative ideas to make your experience unique and captivating.



For our example, we found the experiment on the density of sugar. The experiment is called: coloured density or the rainbow in a test tube.



Figure 4 - Photo <https://www.pickpik.com>

- 3) Define the objective

clearly define the objective of your experiment. What do you want to achieve or demonstrate? Is it to explain a scientific phenomenon, test a hypothesis or present a particular concept? Having a clear objective will guide the design of your experiment.



In our example, the aim of the experiment is to provide a lesson where differences in density are revealed in a coloured set of sugar and water samples.

This experiment allows you to understand the concept of "density" and to grasp the following vocabulary: miscible / immiscible solution, homogeneous / heterogeneous solution.

- 4) Plan the experiment

Break down your experiment into easy-to-manage steps. Identify the materials and equipment needed, the procedure to be followed and the variables you will manipulate or observe. Make sure the experiment is safe, feasible and suitable for video recording.



For our example, first it's a very visual experiment because it's colourful, but it's also very simple to carry out. In addition, the equipment is not hard to find:

- 6 glasses or cups
- Hot water - 1L
- Sugar – 100g - and a teaspoon
- Food colouring – 6 colours
- A syringe or pipette
- A tall, thin transparent container

And we see with the necessary equipment that this is not an experiment with risks (no chemicals or dangerous tools).

For the steps, they must to be written very clearly:

- **STEP 1:** Fill each of the six glasses with hot water.
- **STEP 2:** Use colouring tablets or food colouring to dye the water a different, bright colour in each glass. Stir it completely.
- **STEP 3:** The first of the six glasses will be just coloured water with no sugar. The second colour receives one rounded teaspoon of sugar. The third colour receives two rounded teaspoons of sugar. The fourth gets three teaspoons and so on to five teaspoons of sugar in the last glass. Stir the solution in each glass until the sugar is completely dissolved.
- **STEP 4:** Take the syringe and draw some liquid into the glass that contains the most sugar. Empty the liquid from the syringe into the upper transparent container. Repeat the operation with the other glasses. When emptying the other syringe into transparent containers, do it gently so that the liquids do not mix too much.
- **Step 5:** You made a density column of sugar water, a sugar rainbow!

- 5) Develop a narrative

To create an engaging video, think about how you can tell a story through your experiment. Think about incorporating elements such as an introduction, an explanation of the scientific principles involved, the experiment itself, the analysis of the data and a conclusion. This narrative structure will keep viewers interested throughout the video.

To provide a more tangible context for the experiment, it's beneficial to delve into the various practical applications of the concept in the students' everyday lives. This can help bridge the gap between theory and real-world relevance, making the experiment more engaging and relatable for them.



For our example, we start our video with a dynamic introductory sentence designed to motivate the student from the outset while showing the simple equipment they will have to use.

For a concrete example of this concept, the most impressive example is the boat. How can such a heavy object stay on the water?

- 6) Prepare the experiment

Set up the necessary equipment, prepare the materials and make sure you have a suitable location for the recording. Test the experiment in advance to make sure it works as expected and adjust variables or parameters if necessary.

It's a good idea to prepare extra material if something goes wrong.



For our example, we had to take time with the set-up and particularly with the lighting: **as the aim was to show coloured water, we had to be very careful with the final look of the video.**

In addition, we carried out the experiment several times before starting filming.

- 7) Record the experience

Use high-quality recording equipment, such as a quality camera, stills camera or smartphone, to film the experience. Consider using multiple camera angles, close-ups, and slow-motion shots to add visual appeal. Explain each stage of the experience clearly, providing relevant information and interesting commentary. You will find more information about how to record a video in chapter 2.



For our example of a sugar rainbow experiment, we used:

- a camera, a GoPro for the close-ups,
- and two extra lights to provide the best possible illumination for the solutions.

The voiceovers were added afterwards: they were recorded with a microphone and a computer.



Figure 5 - Photos Fermat Science

- **8) Edit and enhance your video**

Once you've recorded the experiment, edit the footage to create a coherent and visually appealing video. Remove unnecessary parts, add captions or graphics to highlight key points and incorporate background music or sound effects to enhance the viewing experiment. Try to find a good balance between educational content and entertainment value.



For our example, we had to speed up some parts of the experiment to keep the video engaging for students.



Figure 6 - Photo <https://www.youtube.com/@stembot5383>

- 9) Finalise and share

After editing, check the video for errors and inconsistencies. When you're happy with the result, export it in an appropriate format and share it on video-sharing platforms, social media, or your personal website to reach your target audience.

Remember to prioritise safety throughout the experiment and ensure that viewers understand the potential risks involved. In addition, consider including warnings in the video if necessary.



For our example, the video was distributed via the project's YouTube channel and disseminated thanks to the project's distribution throughout Europe.

But before that, we didn't hesitate to share it with our partners, the members of our structures... and we even showed it at a science festival in Beaumont-de-Lomagne (France).

Are you proud of your experimental video? Then don't hesitate to tell others about it!

By following these nine steps, you can invent and create an engaging experience that will captivate your audience and provide them with valuable educational content, as we hope we have done with our video on colour density.

Chapter 2: How to create a video of your experiment – From filming to publishing

Planning the video

Define the objectives of the video

Before filming, it is important to clarify the purpose of your video.

In our case, filming the STEMbot experiment videos, our main objective was to demonstrate the experiment as clear as possible, so that watchers of the video would know exactly how to conduct an experiment by themselves without any doubts. Other objectives included providing a brief explanation of the experiment's result and engaging viewers with the video.

Outline the scenario

Create a scenario or outline to organize your video's structure.

- **The main part – Conducting an experiment**

Outline key points, scenes, and transitions. Before filming, try to conduct the experiment in real to identify any problematic points. Address the identified issues before filming, to avoid having to film everything all over again.

For each section, in addition to the steps of the experiment you will perform, write down the material you need at that time. This will make it easier for you to follow along during the recording and prepare the material needed for that part of the experiment. Many times, we need a lot of material for the whole experiment, which can occupy the entire table. To avoid that, we prepare the material step by step and when we do not need it anymore, we remove it from the table.

Specify the steps in the experiment that will be recorded together. Divide the experiment into several shorter sections, because in this way, if something goes wrong, you can easily repeat only that section; you will not need to repeat the entire experiment. While planning your experiment, find natural breaking points to divide the experiment into several, smaller parts.

Also, think in advance about which shots (or “angles”) you want to emphasize more (close-up shots, captions on the video so that the information is shown more precisely or emphasized).

If you plan to record more videos with the same purpose (more experiments for example), you need to decide if you want them to be unified. In that case, as in STEMbot videos, it is appropriate to set the pointers as brief instructions for recording videos. The pointers can be used also as tips to create educational and clearly instructional experiment videos:

Example: **The pointers, used for filming STEMbot videos**



- Showing just hands from mid-chest down, without face seen.
- Using white background.
- Using white or wood-look table.

- No nail polish or jewellery should be on the hands of the person, who is recorded.
- Using two camera angles, depending on the experiment; one as front view and the other for close shots - if some measurements or details have to be shown.



Figure 7- Source: STEMbot video Vitamin C

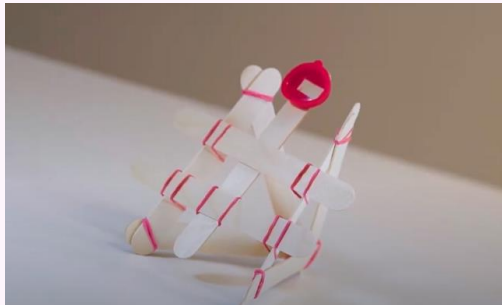
- **The final version of the edited video**

Before filming, you need to think about how the finished video will look like. This is helpful when you want to include special slides/shots, for example shot of the gathered material needed, shots of the final product, etc. When you know how the video will be assembled, you will know which shots you will need. Include these shots in your scenario.

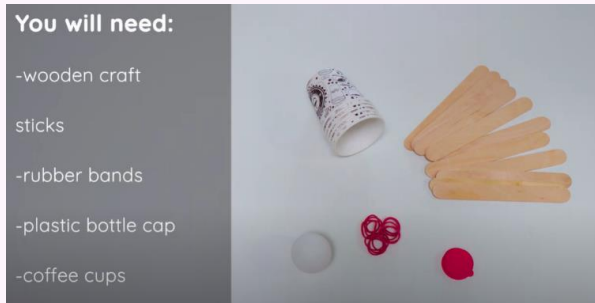
Example: The template for recording, used in STEMBot



- Title slide, presenting the final product of the experiment (1)
- All necessary materials on the table (2)
- Doing the experiment (3)
- Slide with information on how to ask the chatbot for a science background (4)



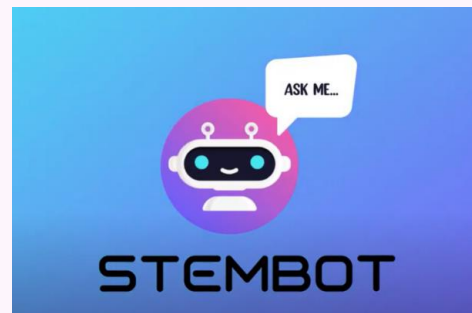
1 - Title slide



2 - Materials



3 - Experiment



4 - End slide

Preparing tools and materials

Before filming, ensure that you have all the necessary equipment and materials ready. Double-check that your experiment materials are in good condition and have been prepared in advance. In the next paragraph, you can find some tips and options for tools and materials you can use in the process of recording videos.

Equipment: Camera, lights, microphone

- 1. Camera

Videos can be recorded through different types of cameras - either a built-in laptop camera, external webcam, smartphone camera, or DSLR camera. The quality of your recording depends on the type of camera and its performance. The minimum specs you will want to record your video are 1080p (meaning the screen size is 1080×1920 pixels, considered high definition) and 30fps (meaning 30 frames per second.) These are the standard guidelines for videos intended to be streamed or viewed online.

For filming the experiment videos, we highly recommend using a DSLR camera, even though an external webcam or your phone camera could also work, depending on your budget and on what is available to you. The built-in laptop camera is not suitable due to its poor performance, which is reflected in poorer quality, and its non-portability, which makes it difficult to capture different recording angles with it.

To record with any of the aforementioned cameras, you need a suitable stand: get a tripod for it. This will make it possible to record quality recordings without shaking distractions.

External Webcam

An external webcam might be the easiest choice for you to record the experiments. They can hook into your laptop and provide much higher quality picture than most built-in laptop cameras. Some webcams can record in 4K and can be mounted on a tripod as well as your laptop or desktop. When searching for the right external webcam, make sure it can record in at least 1080p at 30fps.

Smartphone (iPhone, Android)

Most smartphones are equipped with very high-quality cameras. However, be careful as your phone might not have enough storage to record the entire experiment. For example, 1 hour of recorded video with the settings of 1080p at 30fps takes up 7.6 GB of data! Depending on the model and brand of the phone, one could extend storage with a microSD card. Phones may also overheat if you are recording for long periods of time.

DSLR

DSLR cameras can record crisp, high-definition pictures with true-to-life colours. If you are using a DSLR, you will also need a tripod to mount your camera on, as well as an SD card to record your video onto. This is the configuration we chose for the recordings of the STEMbot videos.

If you would like to record straight from the camera into your laptop, you will need a USB to HDMI capture card, along with the appropriate USB and HDMI cables to hook your camera into your computer. Check, if this option exist on your camera and get a corresponding software.

If you are not recording into your laptop, as mentioned above, you will also need an SD Card to insert into the camera and record your video on. After filming, the card can be inserted into your computer to transfer your video. It is recommended that the card has enough storage space (at least 64GB) and is fast enough for the data to be written to it (speed of 90 MB/s).

If you have the ability (and storage space) on your device to record in 4K, it is welcomed. The higher the definition you can record, the clearer the picture will be for watchers of your video.



Figure 8 - Recording experiment. Source: GoINNO Archive

- 2. Lights

When recording a video, it is important to have the proper lighting. Casting shadows or washing something out with too much light can negatively affect the quality of your video. For the experiment videos, you can use the proper studio lights, but other proper lighting should also work fine.

Make sure you have lots of lights turned on, to help avoid a dark or grainy picture in your camera. Make sure there are no windows behind you and your experiment - the majority of the light should be coming into the room pointing toward you and away from the camera. Besides the ambient light, you will also need direct light - the light that points directly at your subject. If you only use ambient light, you will likely see big shadows on your recording. A few direct lights will eliminate these shadows and bright up the shot.

In a video experiment video, the focus is usually on an activity, done on a table. For this type of video, we recommend a three-point lighting design by placing two lights on either side of your subject at 45-degree angles and a third behind or above your subject. This design adds dimension and moderates shadows and contrast, but still separates the subject from the background.

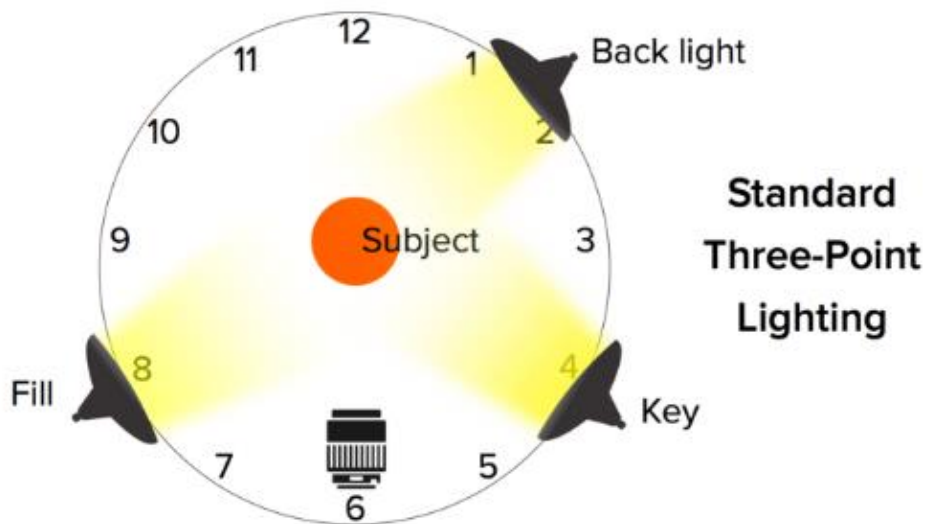


Figure 9 - Picture: Three-point lighting. Source: <https://www.techsmith.com/blog/diy-recording-studio>

As for common lighting gear, there are low budget, mid-range and expensive lighting options; choose depending on your needs and budget allowance.

- 3. Microphones

Audio is critical to your video; therefore, it is important to choose a suitable microphone which will be going to deliver the best quality audio with your video. Take time to find the right microphone for the best results.

For the videos we made for STEMbot, voiceovers were the only way we could include audio to the videos for STEMbot, since we needed it to be translatable and audio recorded while filming doesn't offer enough flexibility for that. Accordingly, we needed a microphone suitable for recording voiceovers.

There are multiple types of microphones that serve different purposes. Which microphone to choose depends on how you will record your video. If you are going to record audio along with video, you must have a microphone that allows this and is connected to the camera. However, if you are going to record a voiceover that you will then add to the video, it is better to choose a microphone suitable for recording only audio, as we have done in STEMbot experiment videos.

Most microphones used for voiceover recording fall into two basic categories: dynamic mics and condenser mics. A dynamic mic uses electromagnetism to convert sound into an electrical signal. It is less sensitive and will pick up less detail than a condenser mic, so it tends to be used for live performances rather than studio recordings. It is also suitable for home studio recordings, if they are not soundproofed perfectly, as a dynamic mic can reduce the amount of extraneous background noise. Another option is a condenser microphone, which responds to audio vibrations using capacitor plates. It allows the production of

highly distinct audio with little self-noise, which makes a condenser mic ideal for audio recording in studios with optimal soundproofing.



Figure 10 - Voiceover recording. Source: Canva photos

The other option you can choose is how the microphone is connected to your computer. If you choose the USB microphone, you can plug it directly into your computer via the familiar USB cable. XLR cables are other common microphone cables, even though they transmit an analogue signal and therefore cannot be directly connected to a computer, without the need of an additional, separate audio interface. USB mics tend to be built with cheaper hardware that produces self-noise and decreases the quality of the recording, however, they are a considerably more affordable option.

Use a microphone that fits your needs and your budget. Test it out, and do not forget that characteristics of surroundings and speaking are crucial for the best voice capturing (quiet area, clearly speaking...). Some tools such as Adobe Enhance may help if you do not end up with the quality you were hoping for.

Materials for the experiment

Prepare all the materials you need to record a particular experiment in a nearby place so that you can easily pick them up and use them during the recording.

Already in the shooting plan, you determine which materials you need for which frame, so you can organize them on the fly as best suits you. Correcting, preparing and moving materials during the recording itself will create unnecessary shots on the recording, which will only confuse the viewer. Our goal is the cleanest and most accurate recording without unnecessary shots, which results from correct and systematic preparation of the material.

If you want to show an image of all the necessary materials for the experiment on the recording, do it at the beginning of the recording, because at the end of the recording you will have already used the materials, and they will no longer be in their original state.



Figure 11 - Picture: Material on the table. Source: STEMbot Experiment video - Hydrophilicity

Space for recording

For background, it is appropriate to use a white wall or something monochromatic. This way, your experiment will be in the centre of the action; too intense a background can turn out to be distracting.

Additionally, a green screen background can be useful as it allows you to replace the real background with a digital one by blending it with your subject. A common example of this is the weather segment on the news, with the meteorologist standing in front of a map. You can create a green screen by yourself using some inexpensive fabric to create a backdrop. Just make sure that you light your subject separately from your background and that they are far enough from the green screen to be easily keyed out in post-production.

The room should be adequately lit. If you also want to record sound, the room should be quiet and properly equipped to prevent echoes, etc. The characteristics of ideal room for recording audio will be discussed in the section dedicated to the voiceover below. In the STEMbot videos, since the voiceovers were recorded afterwards in an optimal audio environment, the choice of the room for filming had no impact on our videos' audio quality.

Safety measures

To ensure safety, it is important to follow certain safety instructions and to be equipped with appropriate safety equipment when working with dangerous substances, also when filming experiments. If the video is intended for children, you should clearly identify the steps in which adult help or supervision is required. Wear appropriate safety equipment, such as lab coats, safety goggles,

gloves, and any other necessary protective gear, as required by the experiment's nature.



Figure 12 - Safety equipment. Source: Canva

Prepare all the materials in a nearby place so that they will be at hand during the recording. In this way, you will avoid unnecessary dangers when you collect materials around the area, the room or even outside it. Otherwise, you could end up with frames being destroyed from your recording, or even with some kind of injury.

First and foremost, if the experiment requires specific safety measures, they should be stated clearly in the video for any viewers that may want to reproduce the experiment at home. If the video should never be reproduced at home, it should also be stated clearly.

Extra caution is required when handling chemicals, hot things like hot water, heated metal, etc., smoke, fire (If you have smoke sensors in the room, you should avoid recording experiments that capture smoke). It is necessary to think about everything in advance and make sure to avoid unpleasant situations during the recording.

Preparing and recording voiceover

Why using voiceovers?

During the recording of the experiments, we found that recording the audio in the form of a voiceover works best. Voiceover allows the narrator to provide a clear and focused explanation of the experiment. This can be especially important when complex procedures or concepts are being discussed, as it allows the narrator to carefully articulate each step and direct viewers' attention to specific aspects of the experiment. By narrating what is happening on-screen, the narrator can guide viewers to pay attention to important details or key observations. Voiceovers provide flexibility in the editing process. If a mistake is made during filming, it is often easier to re-record the narration separately from the visuals, allowing for smoother editing and a more polished final product. In STEMbot, we have also used voiceover as an appropriate way to translate all the experiments. With translating the voiceovers, we did not need to record the video several times in different languages. We recorded one video and then provided 6 different versions of voiceovers in 6 different languages, which were additionally added to the video experiment. For translating, we have used templates, which made the editing easier, removing the need for the editor to know the language being dealt with. Experiment videos often involve some background noise, which can make it difficult to capture clear audio during filming. Voiceovers can be recorded in a controlled, quiet environment, ensuring that the narration is clear and free from interference. Also, they provide consistency in the presentation. Different segments or takes can be recorded and edited together seamlessly to maintain a consistent tone and pacing throughout the video and add a professional touch to experiment videos.

Voiceovers are recorded separately from the experiment, usually after the experiment itself has been recorded and edited. The voiceover script is written while looking at the finalized video. This is then read, recorded and added to the video. The narrator should have a clear and engaging speaking style, and the script should be well-written and informative. It is essential to synchronize the voiceover with the visuals to ensure a cohesive and engaging viewing experience.

Voiceovers can be recorded also using computer or phone microphones, however the most appropriate is using the professional microphone. The recording should take place somewhere very quiet, finding the appropriate distance from the microphone and speaking clearly.

To make the best audio recording, you have to soundproof your environment. In the editing process is almost impossible to fix audio issues. Check for loud noise coming from other rooms or outside, noisier audio is super distracting for viewers. Also, quiet “humms” or buzzes coming from computers, air conditioners or traffic are distracting. Quieter, consistent sounds are easier to edit out than loud noises, but it is best to avoid them. Before starting, do a test recording to see if your audio has a lot of echo (or “reverb”). If so, put some blankets or yoga mats on the floor and walls or invest in professional soundproofing panels.

Start recording the video

Here are our last tips before you start recording:

Check the prepared material and equipment once more.

Look at the **recording plan and find a person who will help you**. This will make the recording more fluid and faster.

Setting up the scene.

Once again, let us stress what was stated in page 28: proper lighting is crucial for the visual quality of your video. Disregarding this aspect and relying solely on ambient light may result in big disturbing shadows showing on your recording. A three-point lighting is recommended.

Make sure in all the sections that you are not blocking the view of the experiment with your body or other equipment.

When filming STEMbot experiments, it was important to target the mid-chest and hands of the person conducting the experiment.



To achieve this, we recommend setting up the camera at this height.

Additionally, make sure to position the camera at a distance that allows for some wiggle room on either side of the picture. This will prevent accidentally cutting off any important parts of the experiment.



Figure 13 - The frame of the experiment video. Source: GoINNO archive

The Frame

You want the important stuff prominently in the frame. For example, in our case, the important were the experiment execution – the positioning of the hands, what and how the person was handling the materials to achieve the result of the experiment.

Technically, there are an infinite number of shots you can take with a camera. We want to limit the angles in order to achieve the purity and clarity of what is shown on the video. There are three main types of shots, and each shot works best in different situations, so you have to choose what you want to show the audience with it. A wide shot is intended to situations when multiple people are in the frame or you want to show the environment in your frame. The close shot, known as “the close up”, is ideal for a highly-focused shots. The medium shot is something between the wide and close shot and can work for almost any type of video.

Example from STEMbot – Types of frames



In STEMbot videos, we have used 2 types of shots (medium and close shots).

Medium for showing the activity in the experiments, the steps, and close shots for the details and important insights.



1
Medium shot



2
Close up shot

Figure 14 - Source: STEMbot experiment video – Natural colouring.

Edit your video

For editing videos, we can use different programs, from very simple to very complex.

Depending on the type of camera used, your video file may need to be converted to a readable format. If your video file ends in .mp4, .mov, .avi, or .m4a, you do not need to convert your video, and you can skip the following step. Webcams, smart phones, and most DSLRs all record in either .mp4 or .mov; you will most likely only need to convert your video if you are recording on a high-quality cinema camera.

Once you've gathered all of your footage, you can import it into a video editing software to implement additional effects and features to polish up your content.

You can choose among different software. Here are some of the most popular editing software on the market:


- Adobe Premiere is widely used, mostly because it has the combination of robust features and an easy-to-use interface.
- iMovie.
- Final Cut Pro. It is professional-grade software that TV and movie studios use and it is a bit tricky to use compared to iMovie or Adobe Premiere.
- Camtasia: Ideal for screencast videos.

With editing software, you can do some colour corrections in the video, add on-screen graphics to help people follow along or emphasize key points, add some static footage, switch between camera angles, zoom in or out, add "fast-forward" if the duration of some actions in the experiment is really long, cut out "dead air",

add music and edit the voiceover. The video will have more energy and life with additional actions and minimized distractions.

Our videos were firstly recorded in a mode without audio content, that is, without sound. We chose the music that we then added to the background. The music should be appropriate, not too slow and not too fast, something inspiring and pleasant that goes quickly to the ear. Pay attention to the volume of the music that you set in the video. It needs to be loud enough to be heard but not too loud that it interferes with the voiceover.

Example of steps for editing STEMbot experiment videos:



Firstly, the video was recorded and edited, without audio. Then we wrote the text for voiceover and recorded it. It was recorded in one-part altogether, then we cut it and connected the individual parts with the related images on the video. In the next step, we added a voiceover to the video.

To make it easier for all the partners to work with translated voiceovers, because we did not understand all the languages individually, we used the template tables for translation. With this we could know exactly which sentence meant what and where it belonged.

Finally, we added the music background, and the video was ready.

Hosting your videos

When it comes to hosting videos for your chatbot, there are two primary options: hosting the videos directly on the chatbot platform or using external video hosting platforms. There are many free options. Here you can find some of the mostly used: YouTube, Dailymotion, Vimeo, Facebook, WordPress Video Hosting, or paid, such as Jetpack, Wistia, Spotlightr, Brightcove, SproutVideo, Uscreen.

Hosting videos on external platform has its advantages and considerations.

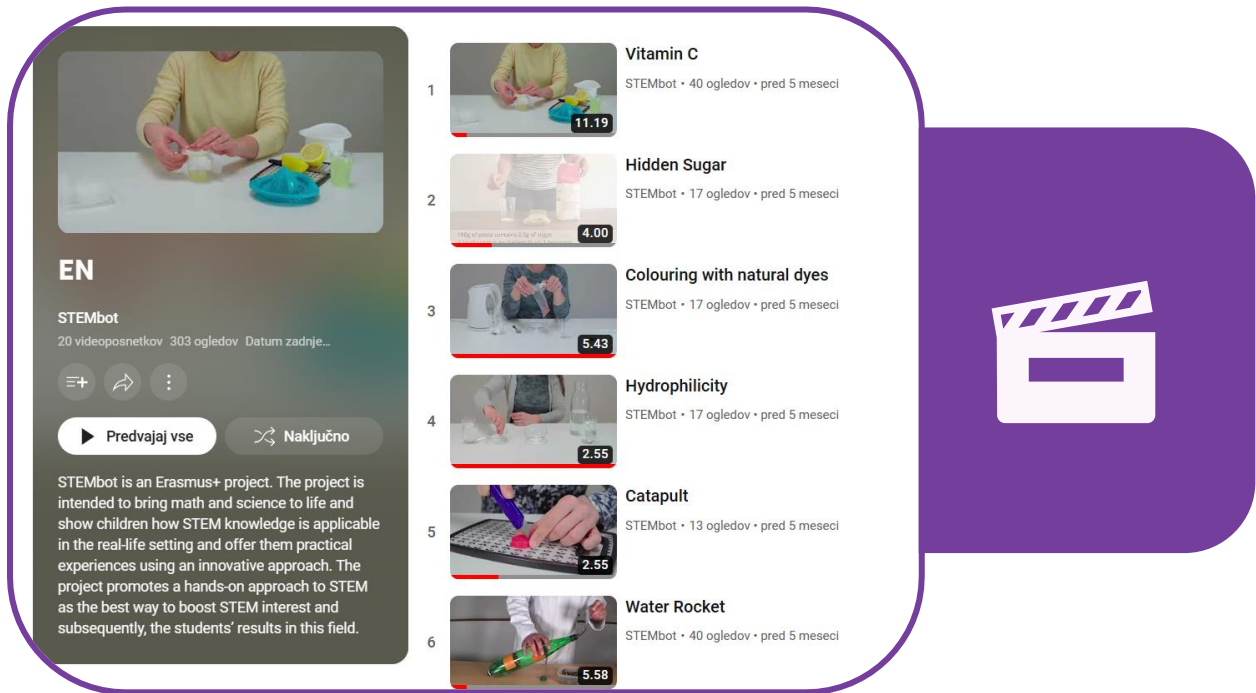
Platforms like YouTube and Vimeo offer ample storage for videos, allowing you to upload a large number of videos without storage concerns. Additionally, they offer features like video analytics, customizable player settings, and embedding options, enhancing your video's reach and engagement.

However, external linking is unavoidable. When video is hosting on external platform, you will need to link the video to your chatbot, which can have a slightly negative impact on user experience. Also, potential distractions, like the inclusion of suggested videos or advertisements after playback, can distract users from your chatbot's content.

Example of hosting on YouTube - STEMbot videos



STEMbot videos are hosted on Youtube. We created a STEMbot video channel with 6 different playlists, referring to different languages. Each playlist features 20 different videos.



EN

STEMbot
20 videoposnetkov 303 ogledov Datum zadnje...

Predvajaj vse Naključno

STEMbot is an Erasmus+ project. The project is intended to bring math and science to life and show children how STEM knowledge is applicable in the real-life setting and offer them practical experiences using an innovative approach. The project promotes a hands-on approach to STEM as the best way to boost STEM interest and subsequently, the students' results in this field.

Video Title	Views	Time
1 Vitamin C	40 ogledov	11.19
2 Hidden Sugar	17 ogledov	4.00
3 Colouring with natural dyes	17 ogledov	5.43
4 Hydrophilicity	17 ogledov	2.55
5 Catapult	13 ogledov	2.55
6 Water Rocket	40 ogledov	5.58

Figure 15 - STEMbot videos playlist hosting on Youtube. Source: <https://www.youtube.com/@stembot5383/playlists>

Chapter 3: How to create your chatbot with Chatfuel

What is Chatfuel? (advantages, disadvantages and alternatives)

Chatfuel is the user-friendly chatbot-creation platform developed by Meta (the parent company of Facebook, Instagram and WhatsApp) for their messaging apps. While primarily designed for businesses to enhance customer engagement, Chatfuel is a versatile tool that can be effectively utilized to create chatbots for STEM education. In this section, we will explore the advantages and disadvantages of Chatfuel.

Advantages of Chatfuel

- **User-friendliness:** No programming skill is required, making it very accessible to educators and individuals with diverse backgrounds. Its intuitive visual interface represents the chatbot's logic through a series of interconnected boxes and arrows, simplifying the process of designing chatbot interactions and flows.
- **Ease of Setup:** The creation of the chatbot is done fully on the web, with your regular web browser. There is no need to download any additional program.

- **Versatility and Reproducibility:** Chatfuel allows you to create chatbots for all three of Meta's messaging platforms: **Facebook Messenger**, **WhatsApp**, and **Instagram Direct**. Once you have learned how to use the interface for one platform, it should not be too difficult to adapt and duplicate your chatbot for the other platforms, enhancing its accessibility, despite a few differences depending on the target platform.
- **Affordability:** A bot made with Chatfuel is free for up to 50 users, making it suitable for small educational projects, for instance with one or two classes. To allow more users to discuss with your bot, the pricing starts at 15€ for up to 500 users per month. You can have a look at their pricing page for more details and up-to-date information:
<https://chatfuel.com/pricing-main>.

Disadvantages of Chatfuel

- **Inability to export chatbots to other platforms:** Once you have built a chatbot within Chatfuel, you are somewhat locked into the platform.
- **Limited AI (Artificial Intelligence) Capabilities:** AI options are limited by default if you want to keep the no-code experience. However, this should not be a significant drawback, as the primary needs for a STEM chatbot are fulfilled: you can add text, images, videos, external links and buttons to design a truly interactive experience. Additionally, Chatfuel now integrates a plugin to ChatGPT, should you need more automatic text generation capabilities.

Alternatives to Chatfuel

While Chatfuel is one of the easiest and most affordable options out there, it is worth knowing that alternatives exist. For instance:

- **BotPenguin:** <https://botpenguin.com/>
- **Botstar:** <https://botstar.com/>
- **ManyChat:** <https://manychat.com/>
- **DialogFlow:** <https://cloud.google.com/dialogflow/>
- **Telegram bots:** <https://core.telegram.org/bots>
- Or chatbot platforms developed specifically for education, such as **Chatbot4VET** (<https://app.chatbot4vet.eu/>) or **Tutorbot** (<https://www.tutorbot.eu>).

We will not dwell on these options here, as this chapter focuses on Chatfuel, the platform we believe to be the most versatile, easy to access (and use), and affordable.

The basics of Chatfuel: Flows, blocks, keywords and user attributes

Creating a Chatbot with Chatfuel is quite intuitive, at least with some basic understanding on how the platform works. In this section, we will guide you through the basic steps and provide key information necessary to create an enjoyable STEM chatbot for your students. This part will mainly focus on making Facebook and Instagram bots, although most explanations will also apply to WhatsApp bots, or at least the process should be very similar.

1. Where to find help

Whenever you need help, or simply want to learn how to use additional features, the first place to head to is, without hesitation, the official documentation:

<https://docs.chatfuel.com>.

Most of your needs should be covered over there, and the documentation should be updated regularly. At the time of writing, though, it is not always crystal clear what feature works with which messaging platform (Facebook Messenger, Instagram Direct or WhatsApp), so you may need to try for yourself.

Chatfuel also integrates a chatbot to help you! Just click on the bot button at the bottom right corner of your window and search for help.

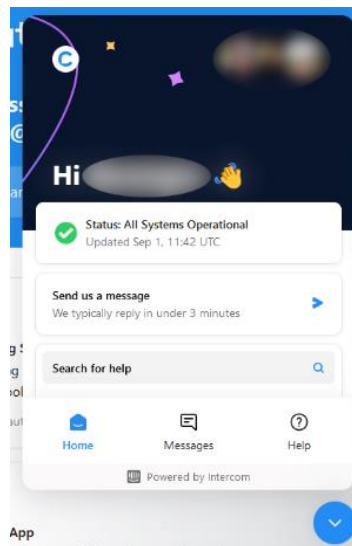
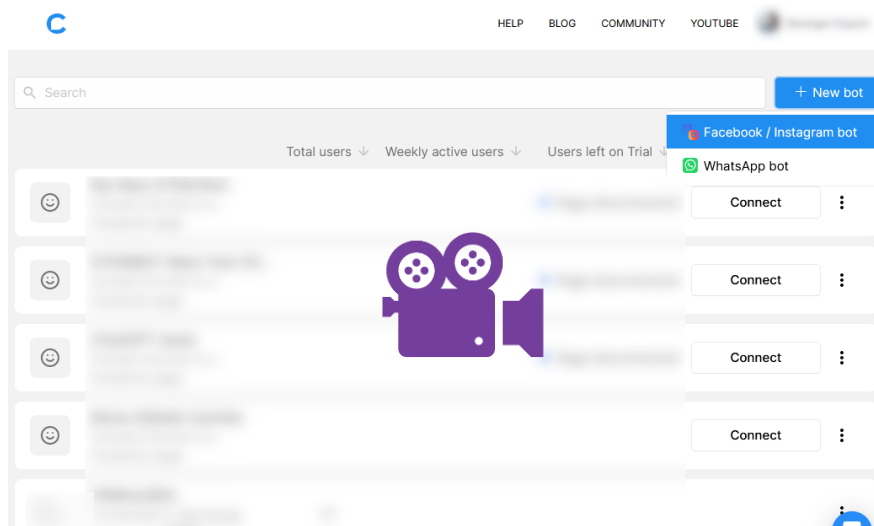


Figure 1 - Chatfuel's Help Center: the chatbot assistant

2. Create a new bot

To create a new bot, you first need to open Chatfuel at <https://chatfuel.com> and log in with a Facebook account. Then simply click on the blue button "New bot" and choose the type of bot you want to create. As we said, in this guide, we will focus on Facebook / Instagram bots, but creating WhatsApp bots is very similar. Once the bot is created, you can easily rename it and click on it to open the bot editor.

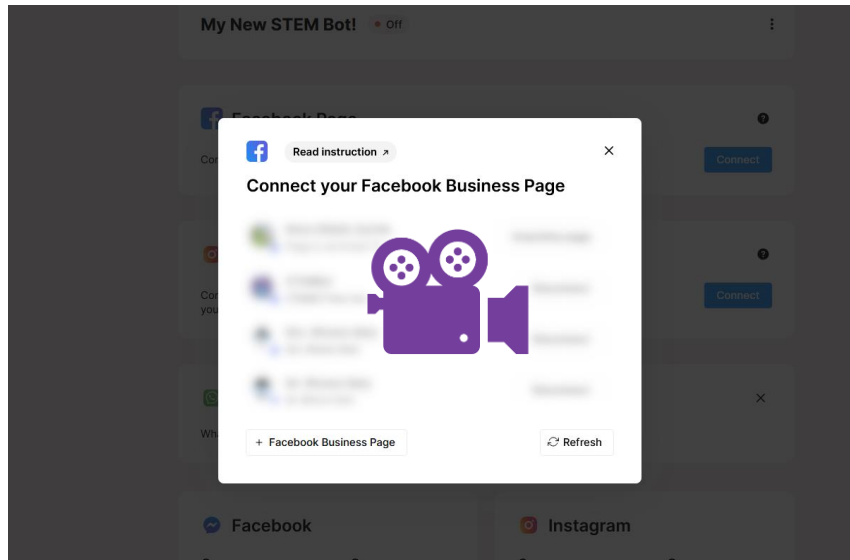


[↑ Watch our short step-by-step video at https://youtu.be/TogUkD9ilog](https://youtu.be/TogUkD9ilog)

3. Link the bot to a business page

To be accessible on the web, the bot needs to be linked to a Facebook business page and an Instagram business profile, if you want your bot to be also available on Instagram. Creating this type of pages or profile is free; any additional cost you may decide to pay should be elicited clearly on the platform (e.g. advertisement). Click on the "connect" button. Any useful information on how to

proceed will be provided to you. You can even create your Facebook business page from there.

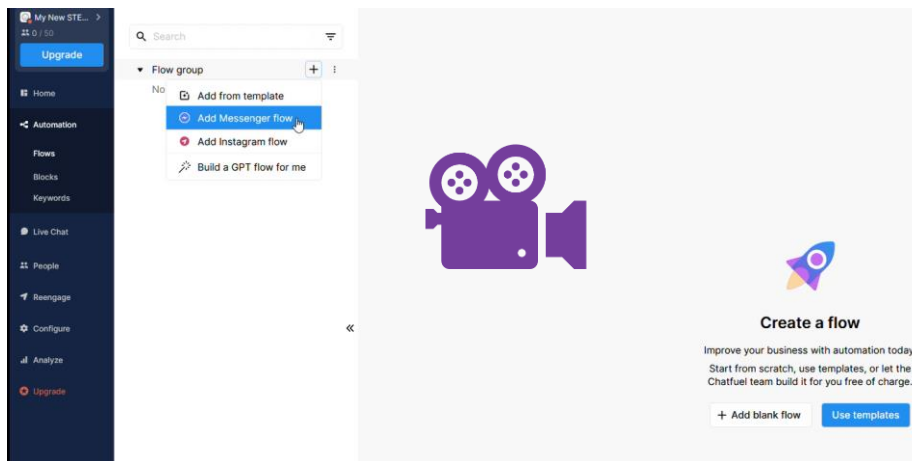


[↑ Watch our short step-by-step video at https://youtu.be/XD1CI8oGH0A](https://youtu.be/XD1CI8oGH0A)

4. Create your 1st Flows

Click on "Automation", then "Flows", on the left side menu.


Then, by clicking on the + sign next to "Flow group", you can create a new Flow. It can be a Flow from a business related template, or a blank one for Messenger or Instagram. Let's select a blank flow. You will then be asked to choose an Entry point. Since it is your first flow, you should choose "Facebook Page" if you are creating a Messenger flow, or "Instagram Direct", for an Instagram flow. Entry points are discussed further hereafter.



[↑ Watch our short step-by-step video at https://youtu.be/hEFHX7cT84A](https://youtu.be/hEFHX7cT84A)

5. Content Blocks

There are several ways to create a Content Block. With your new Flow, you should already have a content block ready to be filled with content. To create a new block, you can:

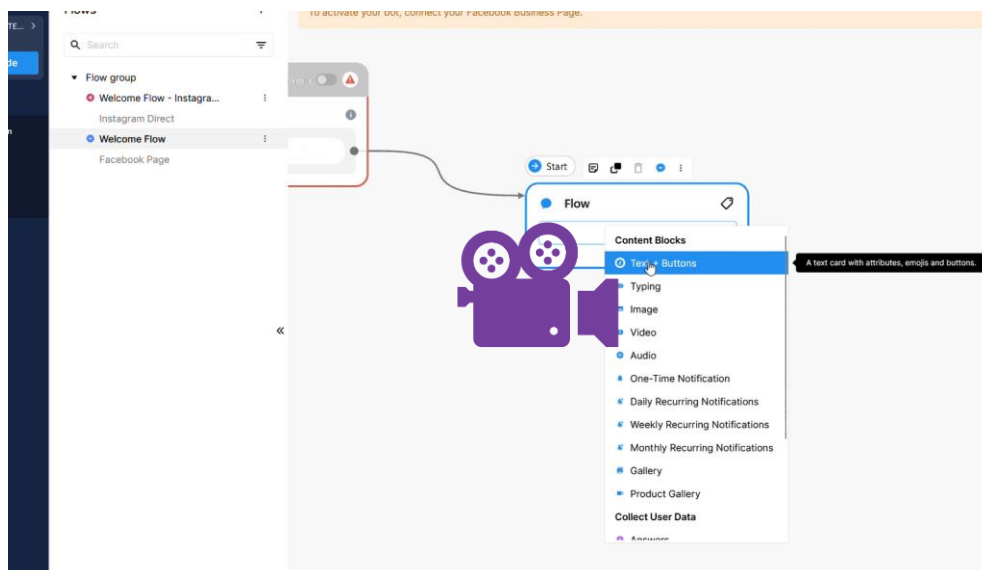
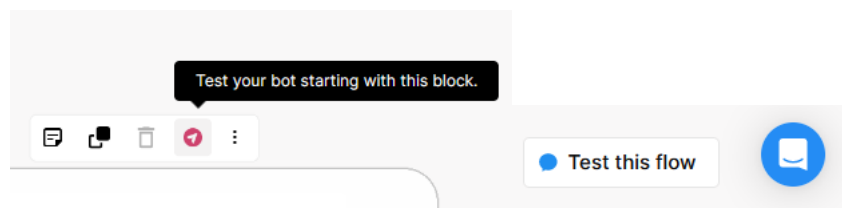
- Right click (or double click) where you want to place the new block in the editor;
- Use the  button on the right menu;
- Or drag a thread from an existing block.

The most relevant Content Blocks may contain:

- Text; Each Text Block can contain up to 640 characters.
- Images;
- Videos;
- Audios.

To avoid sending many messages in a row, you can use "Typing" animations for Facebook Messengers Flows. It does not exist for Instagram, so we recommend to use a "Delay" Action Block in between Content Blocks.

Finally, you can test your Flow by clicking on the "Test this flow" button at the bottom right corner of the window, or on "Test your block starting with this block" when you hover a block.



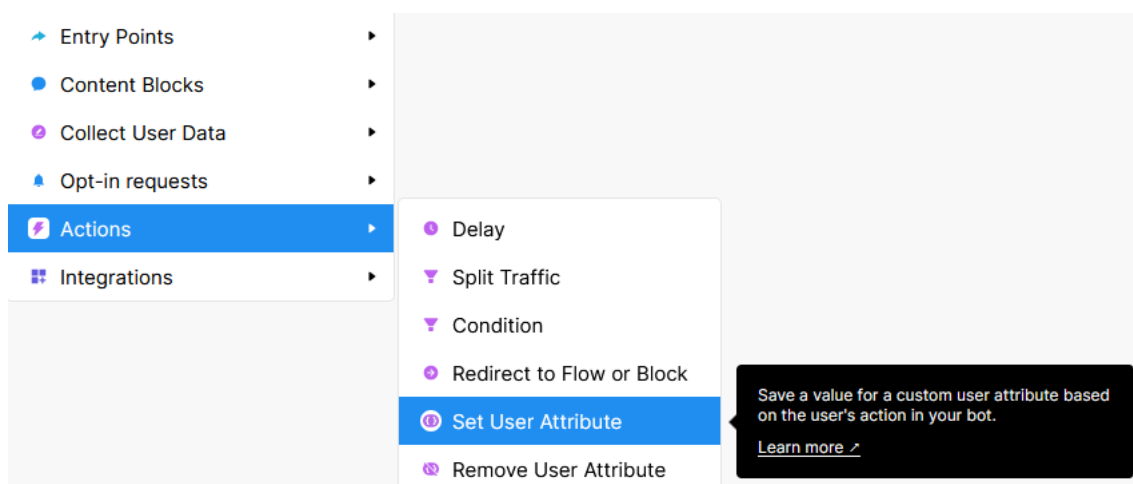
 Watch our short step-by-step video at <https://youtu.be/iOSwMw4qaeo>

6. User Attributes

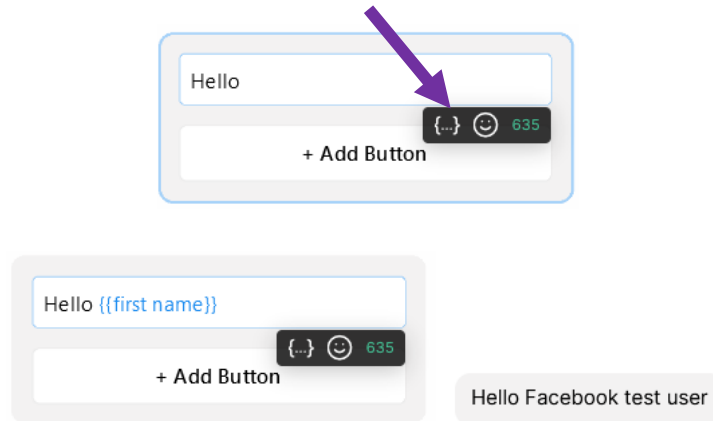
Attributes are pieces of information or values assigned to a user. They can be thought of as labels attached to your user. In programming languages, they basically correspond to variables in a program.

Some attributes are **System Attributes**, meaning that they are automatically available. For instance: the first name of the user on Facebook, their Instagram name, or their locale (i.e. language settings) on Facebook.

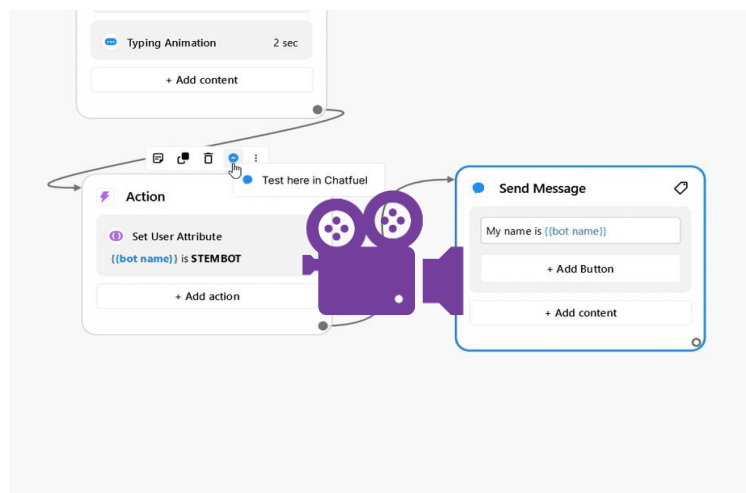
Other types of Attributes are **Custom Attributes**. With these, you can store additional pieces of information. For instance, you can keep a score for an exercise, store some answers of your students (and send this in an email, for instance), or remember some choices that your students make. To set a custom attribute, simply create a "Set User Attribute" Block, as shown in the following picture.



On Chatfuel, Attributes can be used and accessed in a Content Block with text, by using the following syntax: `{{name of attribute}}`. You can type them manually or click on `{...}` in the Text Block editor to see the list of all available Attributes.



On the left: how it shows in the editor. On the right: how it shows in a test conversation (real conversation will display the real first name of the user).



 Watch our short step-by-step video at <https://youtu.be/YrDCBMfIU50>



Advanced tip: You can use Custom Attributes to build a basic database. For instance, to store URLs that you may use at several places of your bot and that may change in the future. Go to "Configure" on the left panel, scroll down and click on "Manage attributes". Then you can create new attributes with default values.

7. User Input

What would be a chatbot without user input? The whole point of chatbots is the power of interactions with the user, isn't it?

You have several relevant options for your STEM chatbot. To be able to interpret user inputs, you'll often need to use conditions, which will be explained below.

- Facebook Messenger (and WhatsApp) Buttons

It is the easiest way to involve users on Facebook Messenger. You can have up to 3 Buttons per Text Block, but you can have several Text + Buttons blocks in a row (i.e. if you need more than 3 buttons, you can just create another Block with additional buttons). Buttons can redirect a user to another Block of your Flow, or to a URL (e.g. a STEMbot video on our YouTube channel).

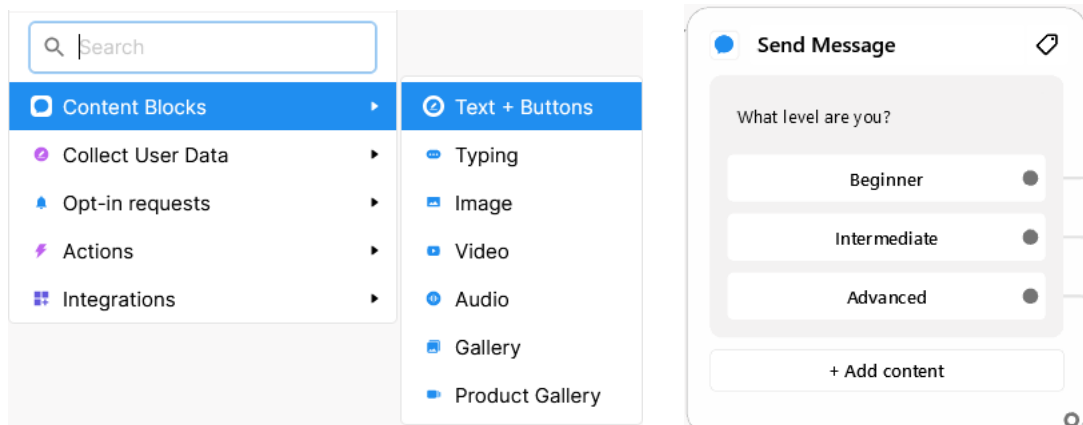


Figure 2 - On the left, how to create Buttons, on the right an example of a Block with Buttons

- Collect Answers

Another way to collect user input is to use "Collect Answers" Blocks. With these blocks, you can collect what users write at a specific point of the flow and store it in a Custom Attribute (c.f. above). For instance, you could save students' answers

to a question and send them to you by email, or save the answers to a Google Spreadsheet document (with the Integrations plugins).

But most importantly, the Collect Answers Blocks are another way to create buttons, which are called "Quick Replies" here. Quick Replies are the only way to have buttons on Instagram (only working on the Android and IOS app). The main differences with Facebook Buttons are:

- You are not limited to 3 Buttons, but 13 Quick Replies at a time;
- They can only be linked to other Blocks of your Flow (not to URLs);
- They disappear when clicked (i.e. students cannot scroll up in the conversation and click on an older Quick Reply)
- You will need to anticipate the fact that a user may type something different, causing the Quick Reply to disappear.
- It pauses the conversation, even if the Collect Answers Block is followed by other Blocks in the Flow.

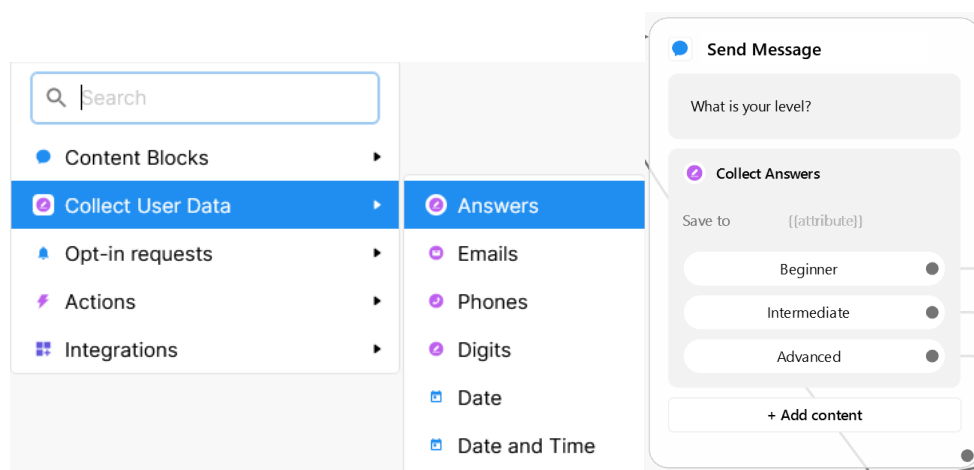
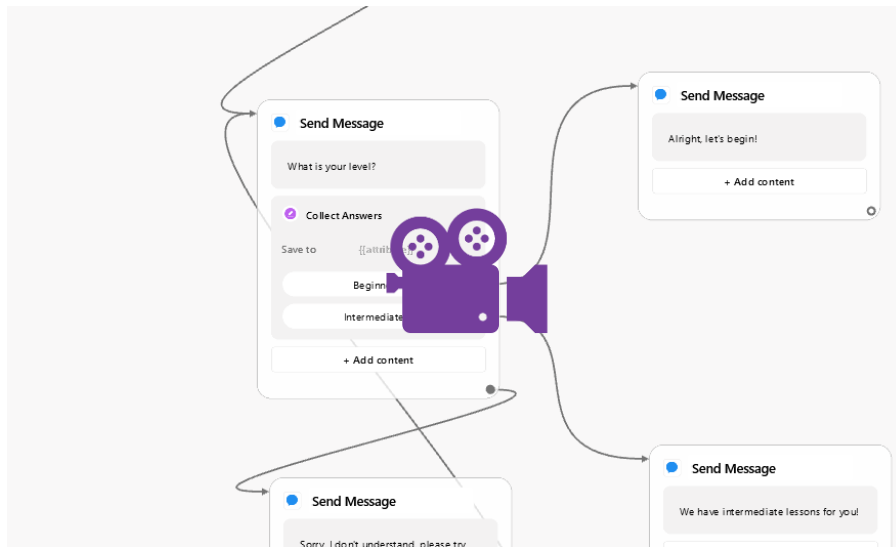


Figure 3 - On the left, how to create Collect Answers Block with Quick Replies, on the right an example of a Block with Quick Replies.



↑ Watch our short step-by-step video at <https://youtu.be/EVsrJrEtb0k>

- Collect Digits

Collect Digits is very similar to the Collect Answers Blocks, except that users will receive an error message in case they enter something else than digits. This type of user input could be useful for when making some exercises, for instance.

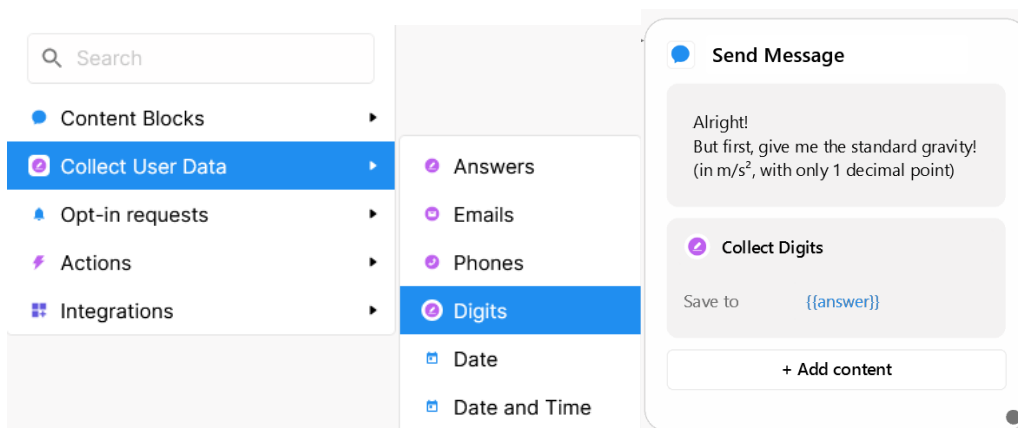
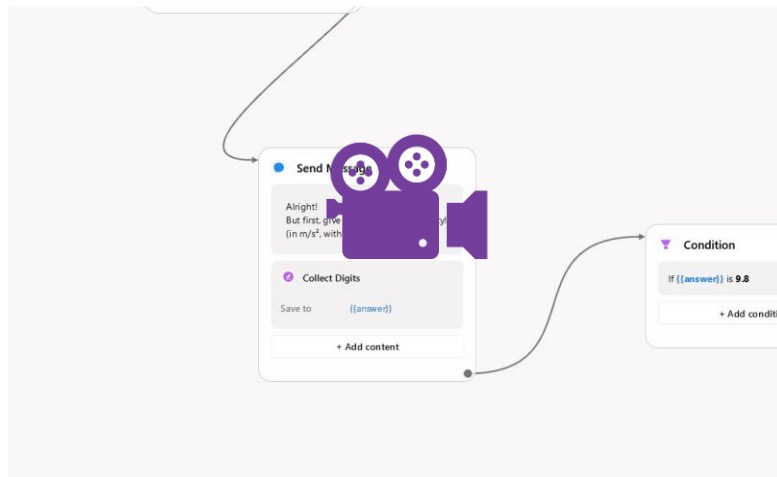


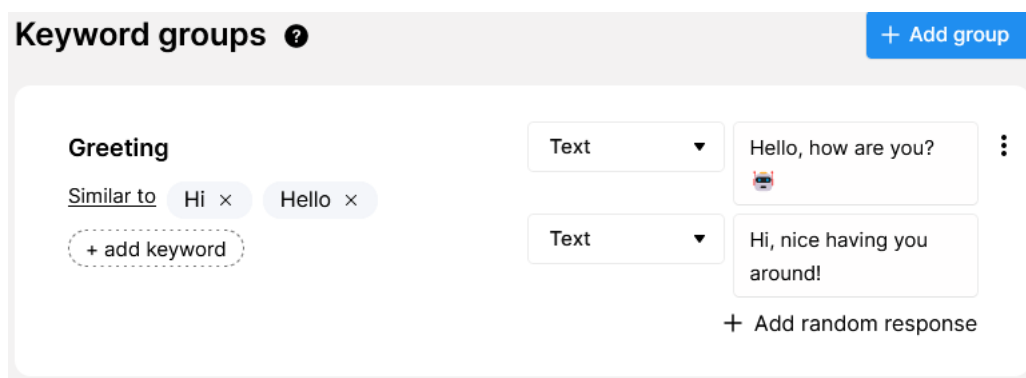
Figure 4 - On the left, how to create Collect Digits Blocks, on the right an example of a Block.



[↑ Watch our short step-by-step video at https://youtu.be/sIQ4DR9WYQw](https://youtu.be/sIQ4DR9WYQw)

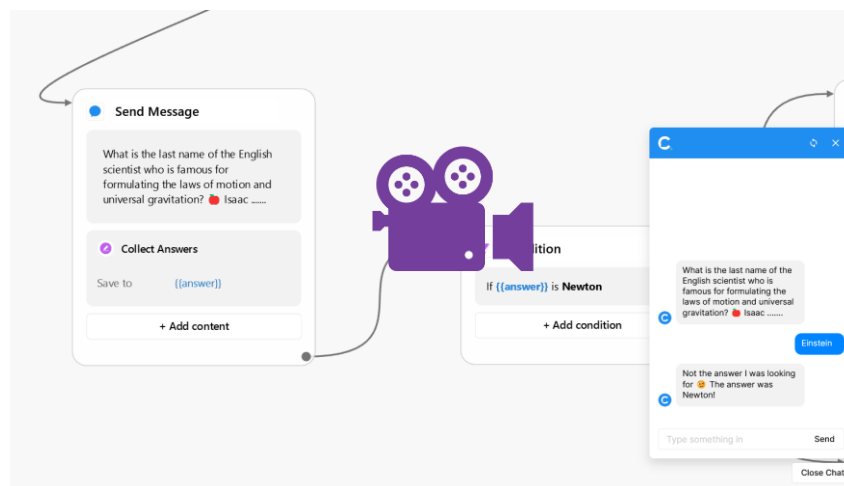
- Keywords in user inputs

You can set up a series of keywords that will trigger a reaction when typed by a user, without the need of a Condition Block (cf. below). For instance, your bot could answer a text message when a user types something similar to "Hi", or "Hello". Or it could redirect your user to a flow about a certain topic when this topic is typed by the user. To set your list of keywords up, go to **Automation > Keywords** in the menu on the left of the window. Then you can create new keyword groups and encode your keywords.



8. Conditions

Condition Blocks are used to check if a condition is met by checking User Attributes (either System Attributes or Custom Attributes). For instance, you could ask a question, save your student's answer in an Attribute and then use a condition to check if the Attribute contains the answer you were expecting.



[Watch our short step-by-step video at https://youtu.be/m08HWv-d9DI](https://youtu.be/m08HWv-d9DI)

9. Entry Points

Entry points tell Chatfuel how users – your students – are going to access a specific flow or block of your bot.

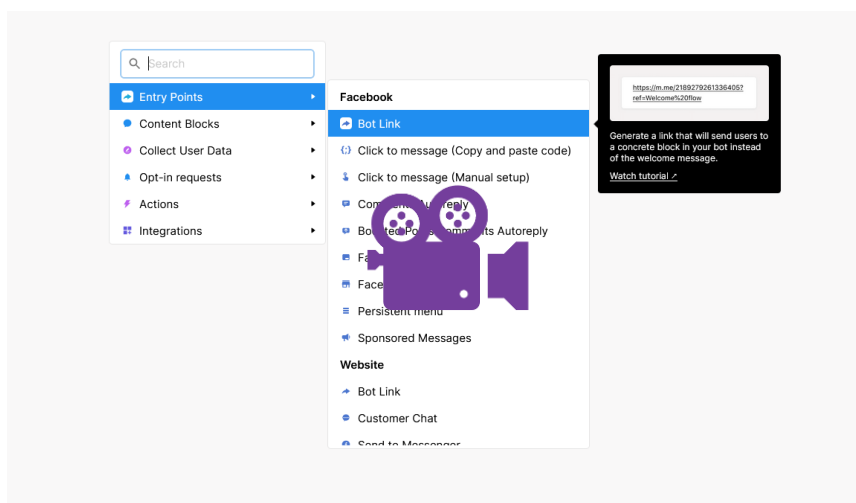
With the creation of your first flow, you should have selected an Entry Point that tells Chatfuel that a user talking to the bot from your Facebook page (or Instagram Profile) should be presented with your first flow. If you arrange your

flows in a way that they are all nicely linked together, or are triggered with specific keywords, it may be the only Entry Point you really need.

But, some other options could be interesting for your STEM chatbot. Here are the most relevant options:

- **Bot Link:** it will generate a link to a specific part of your bot, that you choose. It may be useful if you want to lead your students to a specific part of the bot.
- **Persistent Menu:** You can create a Menu that will always be accessible in the conversation and will allow your students to navigate more easily in the bot. Note that the persistent Menu will not show in the editor's Flow tester, but it will in the actual Messenger and Instagram applications.

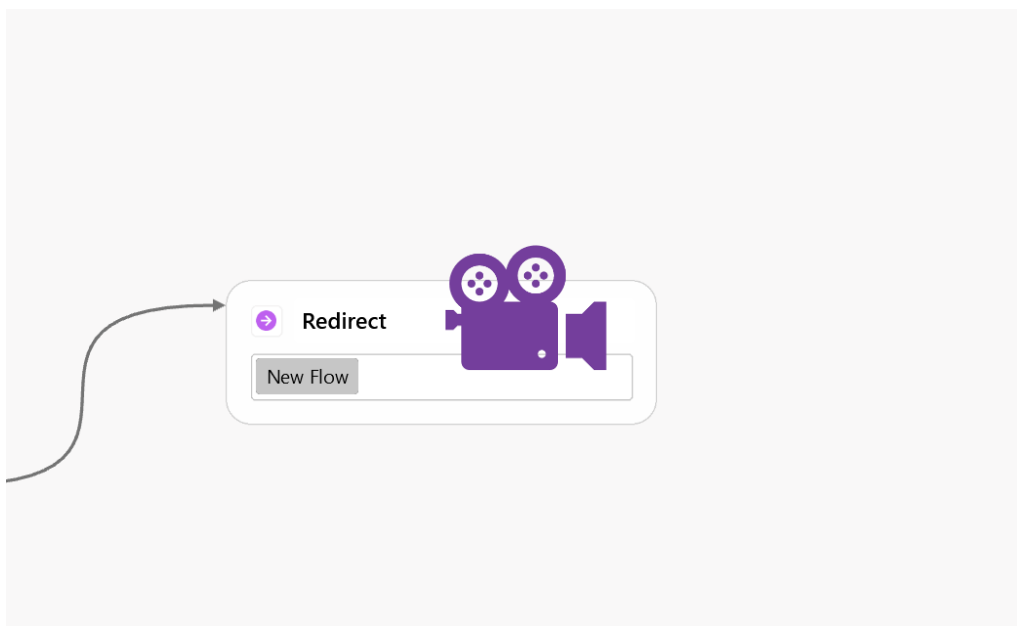
Creating an Entry Point is similar to creating any other Block. Right-click or double-click on the editor, or click on the "New Block" blue icon in the menu on the right. Then, link the Entry Point to the appropriate block(s) of your flow(s).



[Watch our short step-by-step video at https://youtu.be/MXcDGimbq8c](https://youtu.be/MXcDGimbq8c)

10. Redirect to Flow

You may want to create a series of Flows to structure your bot. Doing so will help you organise your bot around topics that you can link to from several places (e.g. from the persistent menu and from other conversation Flows). Linking a flow to another one is very simple: just drag a new path from the last Block of your first Flow, then create a Redirect Block. You can then either redirect to an existing Flow or create a new one.



 Watch our short step-by-step video at <https://youtu.be/n8Ga1SK5yQI>

11. Split Traffic

If you want to add some randomness to your bot, you can with 'Split Traffic Blocks'. With these Block, set up variants of messages that your user could be directed to.

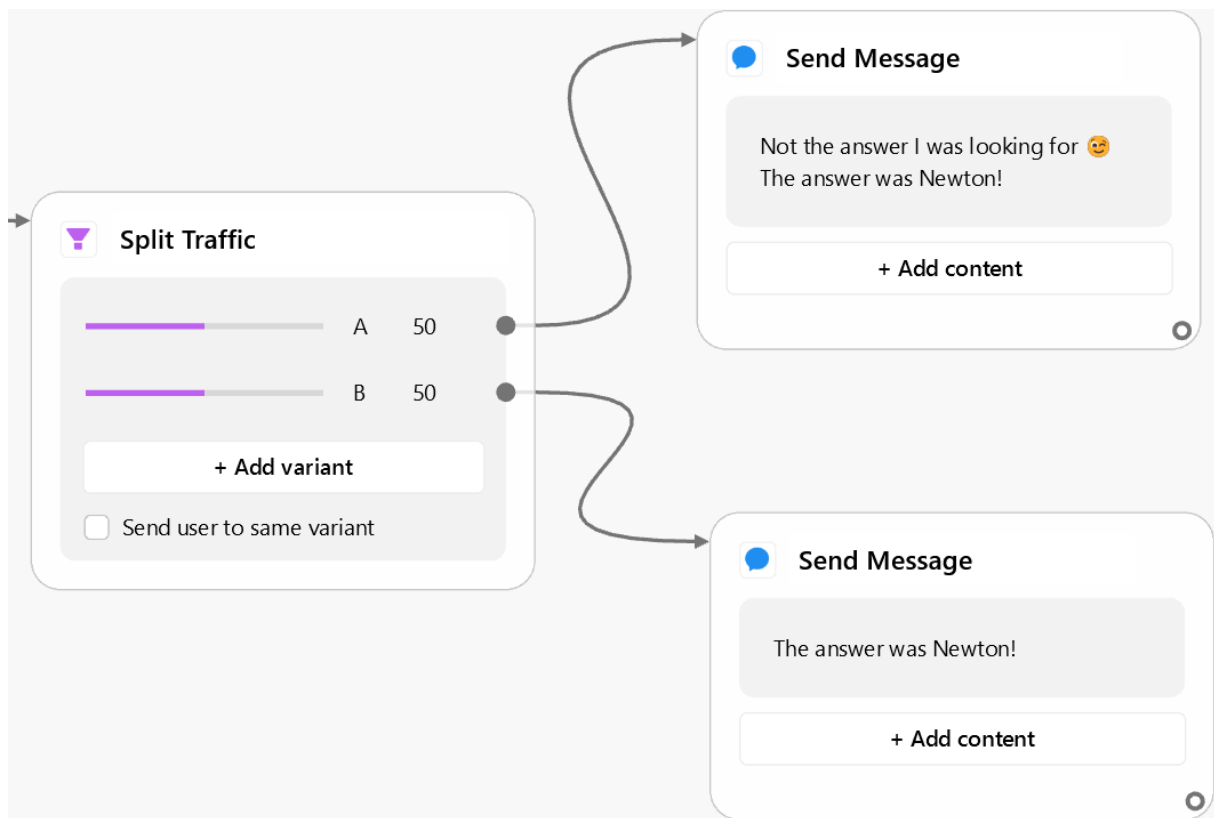


Figure 5 - Example of usage with a Split Traffic Block: The user will be randomly redirected to one of the 2 Content Blocks on the right.

12. Email notification.

Do you want to allow your students to contact you if they have additional questions or do not understand something? You can use the "Notify Admin by Email" Block to receive an e-mail sent from the conversation.

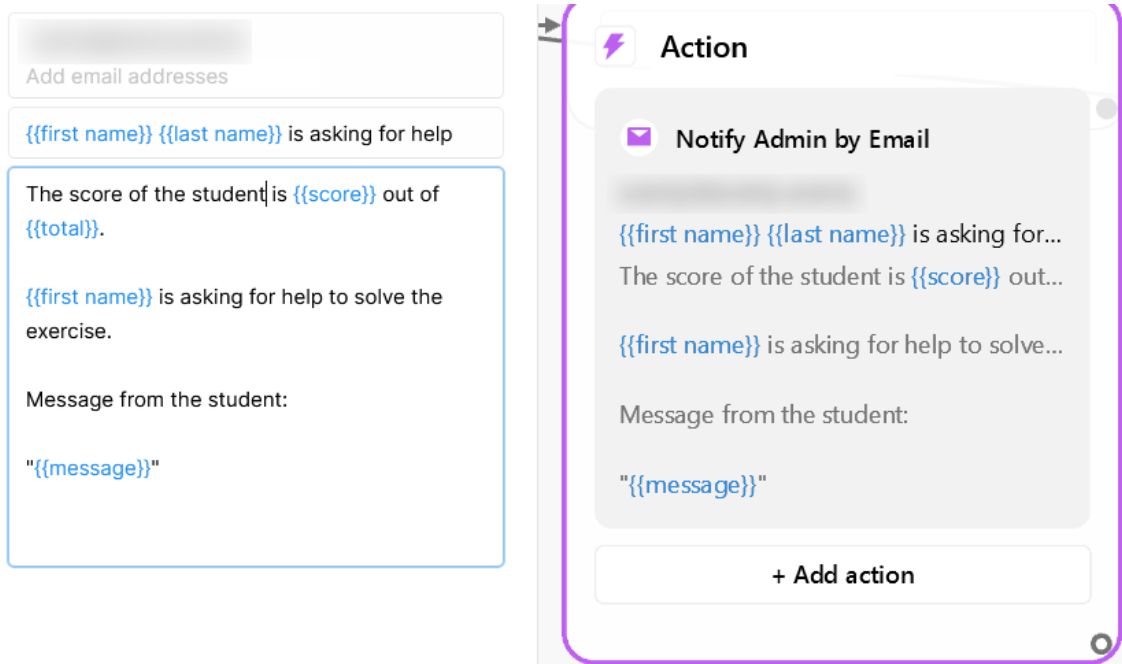


Figure 6 - Automatically send an email to your address with Notify by Email Blocks

13. ChatGPT Integration

Chatfuel in itself does not offer any advanced NLP (Natural Language Processing) tools to improve the interactions with your students and make the conversation feel more natural. However, they offer a plugin to integrate OpenAI's ChatGPT to your bot, with some level of configuration. This would allow you to offer a more individualized experience to your students.

Although we can easily think of many applications, you should be cautious when you use this plugin and be aware that, even with very clear instructions saying to ChatGPT that it should not deviate from the topic at hand, users may always be able to circumvent these instructions and make ChatGPT say what they want.

14. Accessibility

There are no accessibility options directly built into Chatfuel, but you should be aware of some guidelines to make your bot more inclusive and of the options available to your students.

- **Layout:** When possible, try to write 1 sentence per line and offer some space between the lines by using the shortcut SHIFT + ENTER to break the line. This will aerate your text and make it more legible, especially for students with SLDs (Specific Learning Disorders).

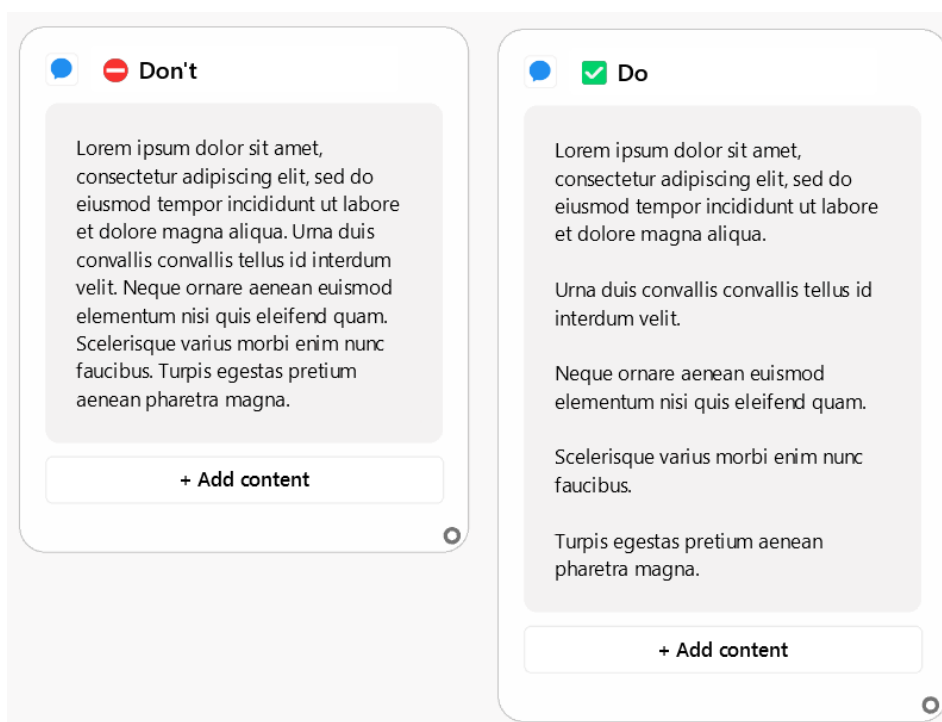


Figure 7 - Same text on the left and on the right. The right one is more legible, especially for students with SLDs.

- Delay:** When you have a series of messages in a row, you can use "Typing Animations" with Facebook Messenger and Delays with Instagram. This will avoid that students receive too many messages at the same time. You should count a delay of about **2 seconds per line** of text in the editor. The goal is to be able to read the message out loud before the next one arrives.

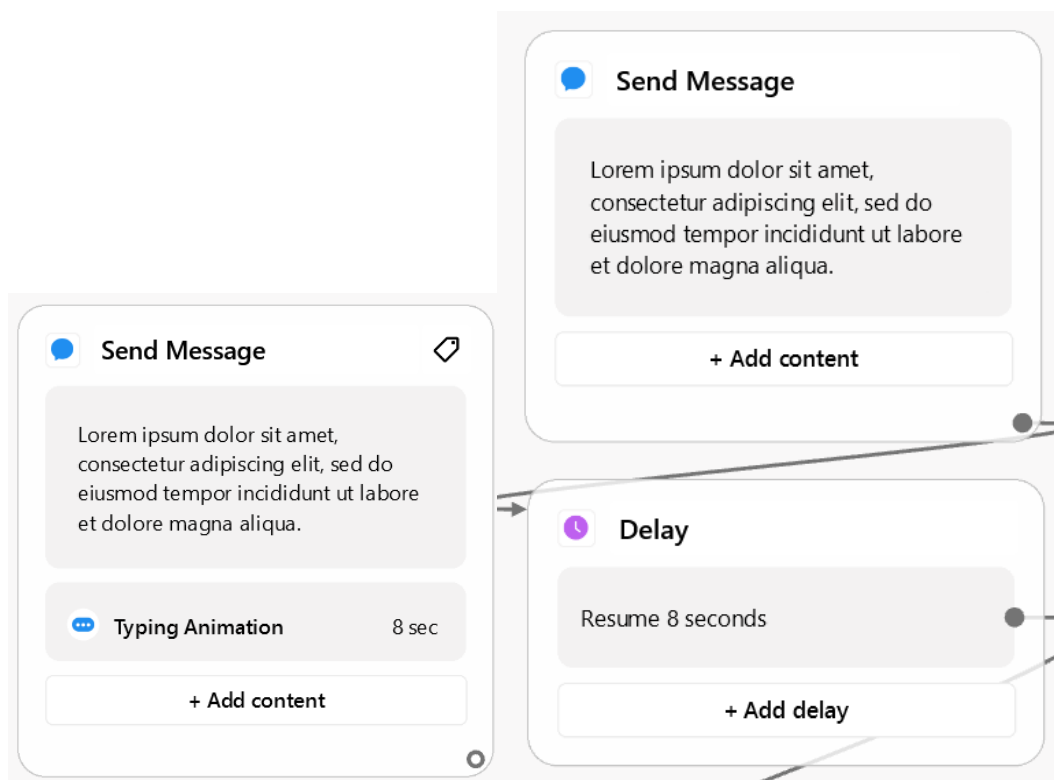
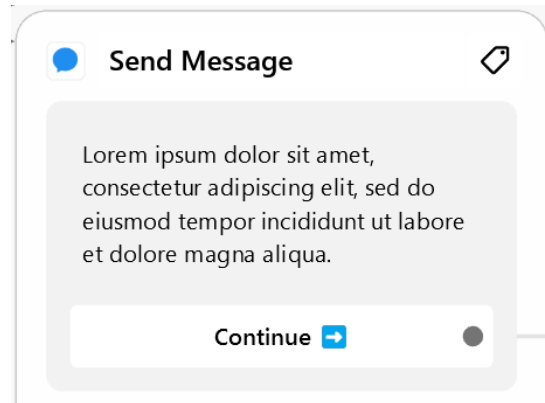


Figure 8 - Example of a message with adapted delay before a following message, on Facebook (left) and Instagram (right). The text takes 4 lines in the editor, so a delay of 8 seconds (4 x 2) was chosen.

- Number of messages before a pause:** Try to avoid having too many messages following each other in a row without a break in the conversation. This is especially important for slower readers so that they do not get frustrated having their reading interrupted by new messages all the time. For instance, avoid having more than around 5 messages before

asking for user input. It can be as simple as a "Continue" Button before the Flow of the conversation can continue.



- **OS and browser accessibility options:** The fact that Chatfuel doesn't allow you to increase the font size shouldn't be too much of an issue in terms of accessibility, as it can be worked on from the user side. Your students should be made aware that they can zoom on the web page (if they are using a web browser), or adapt their accessibility settings on their devices.
- **Use Chatfuel's multimedia integration:** Use images, gifs, videos and/or audio. Students will be more engaged if your content is not limited to text and it will help students with SLDs remain focused on the learning material.

Multimedia library (pictures, videos and other files)

Creating a multimedia library for your Chatfuel-powered chatbot is a crucial step in adding personality, visual appeal, and engagement to your bot. In this section, we'll explore how to effectively use GIFs and images to breathe life into your chatbot, manage your multimedia resources efficiently, and touch briefly on online storage options. The multimedia library you create will not only add personality to your bot but should also help boost student engagement, making learning more exciting and accessible for all, including those with Specific Learning Disorders (SLDs).

Using GIFs and Images to add personality and clarity

Using GIFs and images is a good way to add personality and visual appeal to your chatbot. Here are some tips on how to use them effectively:

1. **Select relevant visuals:** Choose images and GIFs that align with the STEM topics you are teaching. Ensure they enhance the content and provide clarity.
2. **Convey emotions:** Visuals can convey emotions effectively. Select images and GIFs that match the tone and context of your chatbot's conversation.
3. **Illustrate information:** Use visuals to illustrate complex concepts or data, making it easier for students to understand and remember.
4. **Use GIFs as call-to-action:** GIFs can serve as call-to-action elements, prompting students to interact with your chatbot and motivate them to do an exercise or learn a lesson.
5. **Keep it appropriate:** Ensure that all multimedia content is age-appropriate and aligns with educational standards.

6. **Balance with text:** While visuals are powerful, maintain a balance between text and multimedia to provide comprehensive learning experiences.
7. **Optimize image size:** Compress and optimize images to ensure your chatbot remains responsive and quick to load.

Chatfuel does not integrate a GIF selection feature, but finding engaging GIFs should not be too much of a struggle. If you do not know where to look, Giphy.com or Tenor.com are two popular GIF hoster services that may be worth a visit.

Managing Multimedia Content

Efficient management of multimedia content is essential for a smooth chatbot experience. We recommend that you prepare and create several folders on your computer where you will store different multimedia content, categorized by their purpose, emotions, topics, or any other relevant criteria. This organization will help you quickly access and reuse your multimedia content.

For instance, for images and gifs, the purpose of which is to add personality, you could create a folder per emotion you want to display ("laugh", "cry", "happy", "proud", ...), and per function in the bot ("continue", "thinking", "congratulation", "asking a question", "good bye", ...).

You could also create a folder per topic you want to cover and place your PDFs, images, videos and even external links (written in a file) accordingly.

Hosting options for your files and videos

If you want to offer your own files (PDFs, for instance) in the chatbot conversation, you will need to host them online, as Chatfuel does not offer online storage for files. The same applies if you want to use one of your own videos, and if this video is larger than 15 MB: you will need to find other options.

Fortunately, online storage is very simple and affordable nowadays.

- **For files** (PDFs, docx, xlsx, ...), you could simply use a cloud storage provider such as Dropbox, Google Drive or One drive and share the public link to your file in the chatbot conversation. You could do the same for your videos, but there are more adapted solutions.
- **For videos**, you could upload your video on Facebook and integrate the video natively in Messenger or use other platforms such as YouTube.

Create exercises

An essential part in your chatbot creation journey, to harness the potential of this approach for teaching, is designing exercises that not only evaluate students' knowledge but also provide meaningful feedback. In this section, we will explore how you can craft engaging and educational chatbot exercises for your students.

Types of exercise

When it comes to creating exercises for your chatbot, you have three primary options to consider: Multiple Choice Questions (MCQs), open questions and numerical value assessments.

- **Multiple Choice Questions (MCQs)**

MCQs are the go-to choice when working with Chatfuel for several reasons. They seamlessly integrate with the platform, due to the fact that you can simply provide the Multiple Choices as messages Buttons, making them user-friendly and straightforward to set up. Most importantly, they allow you to easily offer instant feedback, guiding students with both correct and incorrect answers. You just need to redirect each Button (i.e. each choice) to the appropriate feedback. This feature makes MCQs very well-suited for quickly assessing knowledge.

- **Open questions**

While open questions are not our recommended choice due to Chatfuel's limited natural language processing (NLP) capabilities, they can still be employed with some caution. By default, open questions within Chatfuel require exact answers, which can work for keyword-based assessments. For those with more advanced programming skills, it is technically possible to implement NLP backend using JSON Requests, enhancing open question functionality (more information: [Chatfuel JSON API](#)).

Alternatively, as discussed earlier, you could use the ChatGPT plugin to harness more powerful NLP possibilities, although with a certain caution. It may not always provide reliable responses and could be diverted from its primary purpose by users.

You could also design the question to avoid having the need of NLP tools. Instead of expecting an immediate answer that students would need to type, you could prompt students to attempt to find the solution themselves before clicking on a button to reveal the answer. This approach encourages critical thinking and research skills, but has the caveat of offering limited possibilities in terms of personalized feedback.

- **Numerical value assessment**

Another valuable exercise format involves collecting numerical values from students and using Conditional Blocks to assess whether their response is equal to, greater than, or less than the expected value. This technique is naturally especially useful for subjects that require calculations, such as physics or mathematics.

- **Word of advice: combine these approaches**

Although several types of exercises are presented, we propose a combination of all; not only to keep students interested but also to cater to various learning styles and abilities, ensuring that your bot effectively imparts STEM knowledge while fostering critical thinking and problem-solving skills.

Exercise design

To create effective exercises for your STEM chatbot, you can follow these few guidelines.

- **Define your criteria**

Start by considering the age group, the interests of your students, and the specific STEM topics you aim to cover. Tailor your exercises to match the level and prior knowledge of your students and let your exercises resonate with your target audience.

- **Provide encouraging feedback**

Feedback is a vital component of the learning process. After each answer, provide feedback that not only informs students about the correctness of their responses but also encourages them to learn from their mistakes. You can go beyond providing simple feedback and foster self-improvement by allowing students to reattempt exercises after providing incorrect answers.

- **Some platform-specific considerations**

You will need to adapt your exercise design to the specific platform you are building your chatbot for, be it Facebook Messenger or Instagram.

- For Facebook Messenger, creating MCQs using text and buttons in Content Blocks is very easy.

- For Instagram, simple buttons do not exist. You will need to use a Collect Answers Block with Quick Replies as buttons. Remember, as explained above, that they do not behave the same.

Going further

Take your exercises to the next level by incorporating the following more advanced techniques.

- **Harness the power of User Attributes**

Utilize User Attributes to keep track of your student's progress. This allows you to personalize the learning experience based on individual performance, tailoring exercises to each student's needs.

- **Your exercise do not have to be all linear: try dynamic questioning**

Keep the learning experience dynamic by directing students to different questions based on their previous answers. Gradually increase the complexity of exercises to challenge and engage learners effectively, ensuring continuous growth and engagement.

Conclusion

In this guide, we have embarked on a journey to harness the power of chatbots in STEM (Science, Technology, Engineering, Mathematics) education. We have learned how to design captivating experiments, and unlocked the potential of multimedia STEM videos. Finally, we have explored Chatfuel, a user-friendly platform for creating chatbots, and discovered several aspects of creating engaging STEM exercises for your chatbot.

Now, you should have all the knowledge you need to embrace chatbots in your STEM teaching, with the STEMbot approach. Be ready to empower students to explore these vital fields in an engaging and accessible way. We expect your STEM Chatbot to have a positive impact on today's learners.

As we conclude this guide, it is evident to us that chatbots in STEM education hold immense potential for transforming the learning experience. By leveraging the power of Chatfuel and incorporating multimedia content and engaging exercises, educators can create interactive and personalised learning environments that inspire curiosity and foster a deeper understanding of STEM concepts. The future of STEM education is undoubtedly bright, aided by the innovative possibilities offered by chatbot technology.

Resources

Chapter 2: How to create a video of your experiment – From filming to publishing

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