



## North Carolina Teacher's Guide

These pages are here to provide additional resources for teachers regarding topics included in *STEM: the Musical*. Information and links to external sources are listed in the order in which they appear in the show. Throughout the guide, we'll list the North Carolina Essential Science and Math Standards that are addressed in the show by giving the standard number (e.g. K.CC.1) and how it appears in *STEM: the Musical*. We don't distinguish between science standards and math standards in the body of the document, but a listing by subject appears at the very end.

We have gone to great lengths to ensure that our content is age-appropriate for our audience. In order to achieve this desired level of specificity, we have in some cases written multiple versions of songs, to be performed depending on the age/grade levels of our audience at a given performance. For example, math is a particularly age-dependent subject, so we have two versions of the song "Math is Everywhere." The first version, appropriate for grades k-4, includes concepts such as greater than/less than, simple addition, subtraction, and multiplication. The other version, for grades 4-8 begins where the other version left off, and introduces concepts such as the Golden Ratio. Our goal is to be inclusive of everyone in the room: the younger students should never be left behind, and the older students should never be bored.

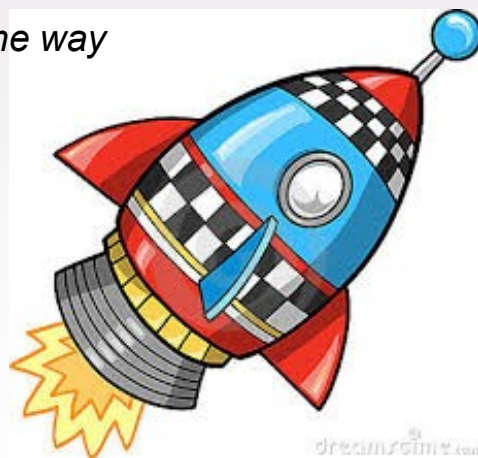
This is not meant to be an exhaustive list of topics covered in the show, and there are likely more standards touched upon than the ones we mention, but this will give an idea of what to expect. If you are looking for information that isn't listed here, feel free to email us at [producers@stemthemusical.com](mailto:producers@stemthemusical.com). Enjoy!

### "How Do We Explore?"

In the opening song, we give an introduction to the simplest form of scientific inquiry: asking questions! Students are encouraged to be inquisitive, and to ask and answer questions about the natural world using explorations, observations, or structured investigations.

Exploration and asking questions are two of the main themes throughout the show, beginning with the opening chorus:

*"How do we explore? We start by asking questions  
They open up the door, to possibility  
The world is full of knowledge, it's our time to lead the way  
Discovering the new horizon, starting here today!"*



# STEM the MUSical

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### The Scientific Method, or “The Steps”

The Scientific Method allows us to form and test hypotheses about the world around us. These basic steps are like the “A, B, Cs” of being a scientist!

In “The Steps” we take the audience through an experiment to find out who is the fastest runner in the class:

1. **Make an Observation** - My friend Aiden runs really fast!
2. **Form a Question** - I wonder if he can run faster than the new girl?
3. **Form a Hypothesis** - No way she can run faster than he runs, he's the fastest in the class!
4. **Conduct an Experiment** - Aiden and the new girl are going to race all the way from one end of the soccer field to the other. We'll wait at the finish line to see who crosses first.
5. **Analyze the Data** - According to everyone who was watching, the new girl beat Aiden to the end of the soccer field by a long shot!
6. **Draw a Conclusion** - My hypothesis was invalid: it turns out Aiden isn't the fastest runner in the class after all!



*“The Scientific Method makes learning a snap!”*

*“We’ll get [our homework] finished up faster than a Hamilton rap!”*

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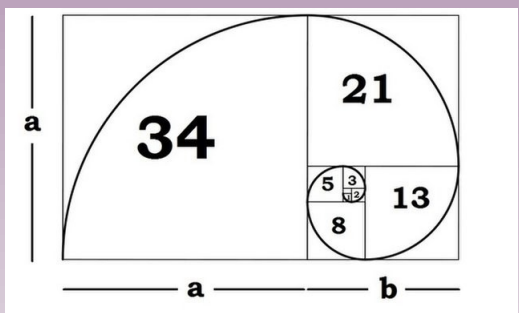
### “Math is Everywhere”

Who hasn't heard the complaint “but how is this useful outside of math class??” In the song Math is Everywhere, one character uses real-world examples to show the others that math isn't just useful in our everyday lives, it's essential to many of the pursuits we hold dear to our hearts (Music! Sports! Food!).

Sometimes in the song “Math is Everywhere” we talk about the Golden Ratio. Here are some more resources to further explain what it is, and where you can see it in your everyday life:

<http://craftwhack.com/golden-ratio-for-kids/>

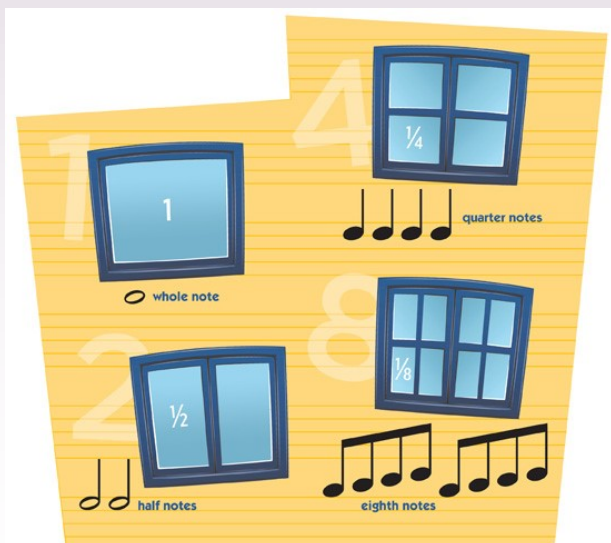
<http://io9.gizmodo.com/5985588/15-uncanny-examples-of-the-golden-ratio-in-nature>



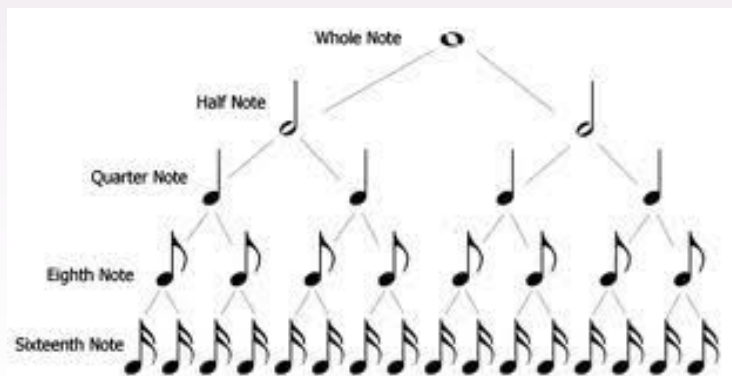
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6.P.1.3; Explain the relationship among the rate of vibration, the medium through which vibrations travel, sound and hearing.



We also cover how music is literally made of math! Some examples of math in music are time signatures, note durations, rhythms, and of course, the vibrational frequencies of the notes themselves.





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## North Carolina Teacher's Guide

### “Math is Everywhere” Continued

K.CC.1; Count to 100 by ones and by tens.

3.OA.7; Fluently multiply and divide within 100

NC.2.NBT.6; Identify how many tens and ones are in numbers up to 30.

We explain that a day – the time it takes the earth to rotate once on its axis – is divided evenly into hours and minutes to make it easier to work with, just as you can divide 100 into 20s, 10s, 5s, or 1s.

1.E.1; Recognize the features and patterns of the earth/moon/sun system as observed from Earth.

3.E.1; Recognize the major components and patterns observed in the earth/moon/sun system.

4.E.1; Explain the causes of day and night and phases of the moon.



*“Time is not a random, made-up notion*

*It's based on interplanetary motion*

*You subdivide the time it takes the earth to spin around*

*Do the math and time is what you've found!”*

K.CC.6; Identify whether the number of objects in one group is more than, less than, or equal to the number of objects in another group, when the quantities are clearly different

NC.2.NBT.4; Compare sets of numbers or objects to determine greater than, less than, or equal

NC.5.NBT.3; Compare whole numbers up to 100 using symbols ( $<$ ,  $>$ ,  $=$ ).

To first introduce the topic of math in our everyday lives, one character asks another if their soccer team won the game last night—and it turns out they did! “How do you know you won?” she asks. “Well, the score was three to two, and three is greater than two!” In this simple example, we see how elemental math is in our lives, starting with the games we play on the playground, all the way up to professional sports statistics and Olympic records!

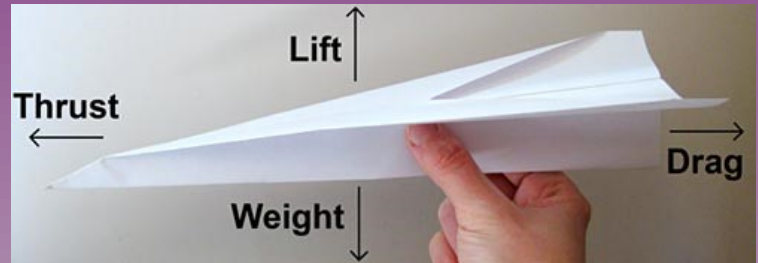


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## North Carolina Teacher's Guide

### Paper Airplane Samba

NC.1.G.1; Identify common two-dimensional shapes: square, circle, triangle, and rectangle.  
NC.2.G.1; Indicate the names of shapes (circle, square, rectangle, and triangle).  
K.G.2; Correctly name shapes regardless of their orientations or overall size.  
1.P.1; 3.P.1; 4.P.1; 5.P.1; 7.P.1; Explain how various forces affect the motion of an object.



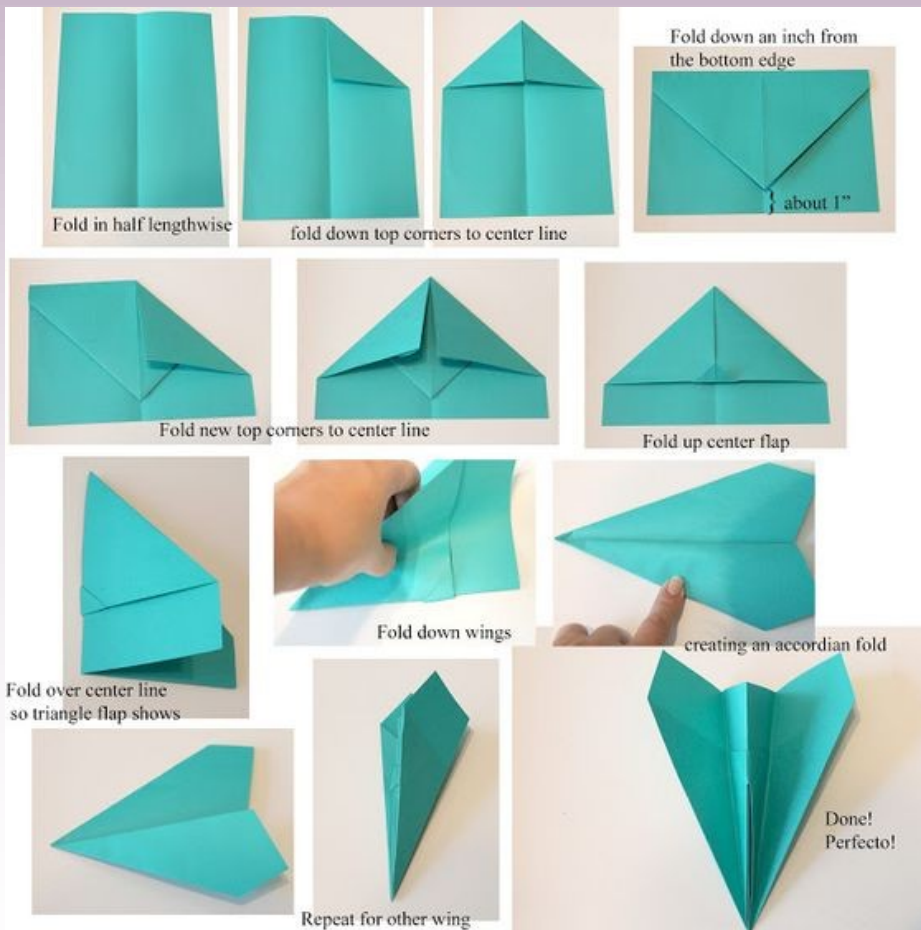
We cover the basic physics of flight, including the forces that act on an object in flight (thrust, drag, lift, & weight), including how some of these forces work against each other, and how that can be overcome.

**Thrust:** This is the force that propels a flying machine. Usually, an engine provides thrust. In the case of a paper airplane, your hand/arm does it.

**Drag:** Also called air resistance, this force acts in the opposite direction of the thrust. It is caused by friction, and differences in air pressure.

**Lift:** This force acts at a right angle to the motion of the flying machine. For example, if the plane is moving forward, parallel to the ground, the lift would be pushing straight up, away from the ground. It is created by differences in air pressure caused by the shape of the wing.

**Weight:** This is the force of gravity - it pulls things down towards the center of the earth.



Want to make a paper airplane in class just like the one we make in the show? Follow these instructions!



# North Carolina Teacher's Guide

## Anti-Bullying

Along the way, we discover that one of the characters has been bullied for being smart and wanting to be an astronaut. The other characters tell her that she can be anything she wants to be, and they encourage her to go for their dreams.

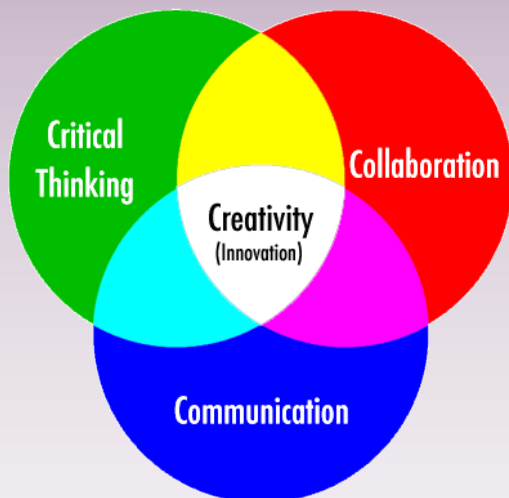
K.ICR.1; 1.ICR.1; 2.ICR.1; 4.ICR.1; Understand healthy and effective interpersonal communication and relationships. (K.ICR.1.4; Recognize bullying, teasing, and aggressive behaviors and how to respond.)

## “Go Explore!”

In our finale, we bring the message of exploration full circle, including a powerful call to action for the scientists, inventors, and creators of tomorrow. We give examples of famous scientists who failed many times before succeeding, and frame failure not as the end of an endeavor, but the beginning!

1.MEH.1; 2.MEH.1; 6.MEH.3; Understand the relationships among healthy expression of emotions, mental health, and healthy behavior. (1.MEH.1.2; Use methods of positive coping with disappointment and failure; 6.MEH.3.1 Interpret failure in terms of its potential for learning and growth.)

*“It is now your time to be strong and to lead  
Be the change and make the discovery  
You will do things no one has ever imagined  
There’s nothing that you can’t achieve –  
Go explore!”*



## NC Math Standards Addressed (chronologically in the show):

K.CC.1; K.CC.6; NC.2.NBT.4; NC.2.NBT.6; NC.5.NBT.3; 3.OA.7; 4.OA.1; 4.NF.4; 5. NBT.7; NC.1.G.1; NC.2.G.1; K.G.2

## NC Science Standards Addressed (chronologically in the show):

1.P.1; 3.P.1; 4.P.1; 5.P.1; 7.P.1; 1.E.1; 3.E.1; 4.E.1; 6.P.1.3

## NC Healthful Living Standards:

K.ICR.1; 1.ICR.1; 2.ICR.1; 4.ICR.1; 1.MEH.1; 2.MEH.1; 6.MEH.3; 1.MEH.1.2; 6.MEH.3.1

# Why Not **STEM** *the Musical?* and #iamthenext

## “Why is it ‘STEM: the Musical’ and not ‘STEAM: the Musical’?”

This is a question we’ve gotten several times, so we wanted to make it clear: the arts are absolutely vital to what we do and why we do it! In fact, a desire to bring professional-quality musical theatre into schools - and perhaps in front of students who had never seen it before - was a driving force behind this show’s creation.

We went back and forth about what to name our show, and we decided that while the “A” is the vehicle by which our story and content are delivered, the content itself is more strictly STEM-related. The “STEM” is the *what*, and the Arts are the *how*.

## #iamthenext Social Media Contest

In our closing song, we encourage audiences to rise up and take their place among the stars - both literally and figuratively. Each actor introduces themselves and tells us their dream. For example: “I’m Tyra, I play Stella, and I am the next recording engineer!” After that, we turn to the audience and ask “What’s *your* next?” What is it that you’re going to shine and excel at? This can be in any field of interest to the student - we just think it’s important to pass the baton and let them know they are the next group of leaders in ALL fields.

To that end, we’ve created an activity and contest for students once they’ve seen STEM: the Musical. Using the PDF on the next page, we want students to tell us about their dream - what is their next? What are they going to become someday? Please instruct students to color the page however they’d like, and either write or draw a picture of themselves doing their dream job. It can be *anything* they imagine.

Then, take a picture of them holding their art (or lay it on a table if they’d rather not be in the picture) and either email the pic to [producers@stemthemusical.com](mailto:producers@stemthemusical.com) or Tweet it to [@stemthemusical](https://twitter.com/stemthemusical) using the hashtags #iamthenext and #stemthemusical for a chance to be featured on our Twitter and Instagram feeds!

#iamthenext

**name:** \_\_\_\_\_

**age:** \_\_\_\_\_

STFMM  
the Musical