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Qu'est-ce qu'il y a dans le ciel étoilé? Basic Astronomy for Middle School French Students

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Rationale and Initiation

This unit will use the idea of constellations as a vehicle by which to teach basic astronomy content to middle school French language students. Other foreign language teachers are encouraged to use this framework and adapt the vocabulary to suit the teaching of whatever language taught. The format of this unit is inspired by two children's books written and illustrated by H.A. Rey, *Find the Constellations* and *The Stars: A New Way to See Them*. The simple language and clear, concise sentence structure used in both serves as a wonderful model for a content-based unit on the stars, taught in a foreign language.

The stars and the solar system are part of the fifth grade science curriculum in my school, so students will already have a foundation of knowledge about the content of this unit. Students will be able to draw on prior knowledge to navigate the information in the foreign language; this will bridge the gap between the unknown (the foreign language) and the known. It will give students a level of security most will not have in learning content in a foreign language. Although I will teach this unit to my 8 th grade class, it can be adapted to any grade level. I can already envision the pride on my students' faces when they see how far they have come, to now be learning science in a foreign language!

I will begin the unit with a background lesson on stars and magnitude. I provide lesson-starters in the next two sections that model the simplicity of the target language to be used in conveying this not-so-simple information. To be certain that the information is clear, the English equivalent will follow each French language section; it is meant for the teacher, but may be used to help reach students who need extra assistance. Although it will be difficult, students will likely show enthusiasm for this method of conveying content through language immersion, because the language will be comprehensible and, combined with the prior knowledge they have, will result in greater understanding. [1]

We will swiftly immerse ourselves in the constellations, those imagined images one can form by connecting the star-dots in the sky. In total, we will explore 11 constellations (and 2 asterisms), including notable stars, position in the sky, and a little bit about the Greek myths surrounding the constellations. I intend to teach this unit in January, and so I have chosen to highlight constellations that are easiest to see in that month. A quick look at any resource on constellations can tell you the best times of year to see each constellation, so that you

may customize the material to suit your needs; I used Rey's book *Stars*.

Throughout the course of this unit, students will learn the concept of magnitudes of brightness, the names of all 20 brightest stars in our sky, light-year distance relations, and why our views of the stars changes over the course of a year; that learning will revolve around this foundation of constellation images. Information that is otherwise meaningless to the average middle school student will now feel meaningful; students will relate information about magnitudes and distances to the pictures they will see in the sky; in this way constellations will become the ultimate memory tool! Students will not learn the vocabulary because they memorized it, but instead, because they used it. Meaning-based learning is fundamental, and students remember vocabulary that they need. The names of stars will now be important, as they will help a student orient his constellation image in the sky. By using simple French language I will convey this information to students, and we will take it apart and put it back together again, practicing the vocabulary and sentence structure amidst this new and exciting atmosphere of the stars in our sky.

After students have a firm grasp of the stars and constellations introduced, we will discuss how and why what we see in the sky changes over the course of a year. Students will reproduce general sky-view charts, and will then move on to the task of creating individual charts representing views by season, that we will then join together with paper fasteners to demonstrate the way the sky-view changes with the seasons.

Finally, we will use manipulative models to help us move from the two-dimensional plane of the celestial sphere to the three-dimensional space which these stars actually occupy. To comprehend the relationship between the flat, connect-the-dots pictures of the constellations, and this real space with seemingly infinite depth that the stars inhabit, will be difficult for many of the students, and will require clear language and effective demonstrations on the part of the teacher.

Manipulative materials will be used throughout the unit to help students understand the relationship between stars and constellation images, as well as the relationship among stars, and between the stars and the Earth. Transparency overlays will help students "connect-the-dots" between stars to form constellations, by showing where the connecting "lines" should be envisioned. This tangible method of showing what the sky would look like if you actually did connect the dots is fun, and it makes this fluid concept more concrete. Students will create several sky images and develop their own way of demonstrating for the class the way the stars can form the image of a constellation. Students may use pipe cleaners, thread, fabric, collage, watercolor painting on transparencies, glitter, sequins, word collage; in short, students will be encouraged to be creative as they create flat star images, comprised of individual "stars," that are accurate in relative size to portray magnitude. Next they will work with three-dimensional objects to translate the flat pictures into full space models. Collaboration with an arts teacher will be beneficial, although it is not necessary.

The unit will culminate in several different projects. Each student will contribute to at least one, and motivated students will contribute to several and serve as leaders for each project. Students will:

- A) Create four different sky view charts, based on the seasons, to be fitted together to create one large "general sky view chart."
- B) Create a bilingual children's book that teaches the content of our unit to 5 th graders. This will let students process the information and exercise creativity in presenting factual information.
- C) Read/perform this book to the 5 th grade class at the end of that class' solar system unit, and present a copy to the class as a gift. According to Edgar Dale's "Cone of Learning," people retain 90% of what they teach to someone else, and this will also serve as a community-building exercise within the school.

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This unit will reinforce the science skills students developed in 5 th grade concerning the solar system, and will exercise student's mathematical capabilities by requiring them to make simple calculations in French, comparing the distances, in light years, of the 20 brightest stars from each other. We will develop literacy skills by thinking about how to create a bilingual children's book that relates the knowledge learned. Spatial relationships will be stressed (no pun intended!), and language acquisition will occur with the purpose of following directions and conveying information to others.

Learning about the stars and the constellations they create is much more than a wonderful way to hook students to teach them content, although it is clearly that. The sky is something we all have access to, regardless of cultural or financial background. It is important to teach students to appreciate the world around them, as well as to appreciate that which is free. In this way, basic astronomy knowledge opens the door to sky as canvas, sky as storybook, sky as companion; this further opens the door to other unconventional means of telling stories, conveying information, or experiencing the world. Students need to know that they can and should pursue what interests them, that the possibilities for creation and understanding are endless.

I find it particularly relevant that H.A. Rey, the author of *Finding the Constellations* and *The Stars: A New way to See Them*, is perhaps better known as the author of the celebrated *Curious George* series of books. He was a scientist by profession, and is a great example of how the arts and academics can be integrated. He did not pigeonhole himself into one category, that of scientist or that of author or storyteller; he did what he felt to be right and true to himself and his interests. I teach at an arts magnet school in New Haven, Connecticut and, although this fits perfectly into my school's curriculum, it really has a place in the education of any young person.

Lesson Starter: Les Étoiles / The Stars

To begin this section, I will use gestures and word-emphasis to convey what a star is. This definition will be built upon in the next section. I will then introduce a word that students may not recall, *sembler* (to seem); I will use it in the context of the stars, that some seem to shine brightly, while others seem more dim. Instead of defining the verb *sembler* in conventional terms, I will act out a scenario in which the definition will be apparent. By modeling the meaning of the word using vocabulary students know, combined with an immediate example to which they can relate, students are able to figure out the meaning of the word and then transfer meaning to the new context. This is not only a better way for students to learn, but it is also more fun and rewarding for them. This will set the pace for the whole unit, that we will be using what we know to figure out or learn what we don't know.

En français : Un nuit, il faut lever les yeux, et regarder le ciel. Qu'est-ce que tu vois dans le ciel? Il y a des étoiles, beaucoup d'étoiles. Mais qu'est-ce que c'est une étoile? Une étoile, c'est une gigantesque boule des gaz chauds et lumineux. Si les gaz sont très chauds, ou si l'étoile est très grande, puis l'étoile est très lumineuse – elle émet beaucoup d'énergie, et donc elle émet beaucoup de lumière. Si les gaz ne sont pas très chauds, ou l'étoile n'est pas très grande, puis l'étoile n'est pas très lumineuse – elle émet seulement un peu d'énergie, ou lumière. Donc, la luminosité d'une étoile, ou la somme de l'énergie qu'elle émet, est un produit de la chaleur des gaz de l'étoile et des dimensions de l'étoile. Comment dit-on *chaleur* en anglais? Regardez et

écoutez: *Il fait chaud. Je ne peux pas supporter cette chaleur!* C'est clair? Continuons.... [3]

À nos yeux ici, à la Terre, il y a des étoiles qui semblent à briller beaucoup et des autres qui semblent à briller seulement un peu. Les étoiles qui semblent à briller beaucoup ne sont pas toujours les étoiles qui sont vraiment les plus brillantes. Regardez-moi. (Je monte une chaise.) Je semble à ítre très grande, comme une giraffe ou mon mari, Monsieur Swaim. Mais en fait, je ne suis pas très grande. J'ai monté une chaise, c'est tout. En fait, je ne suis pas grande, je suis un peu petite, comme Alexia ou (n'importe quelle célébrité courte). Donc, pour les étoiles qui semblent à briller beaucoup, peut-être qu'elles brillent vraiment beaucoup, ou peut-être qu'elles brillent seulement un peu, mais parce qu'elles sont très proches à la Terre, elles **semblent** à briller beaucoup.

English Translation: One night, you should look up (raise your eyes), and look at the sky. What do you see in the sky? There are stars, many stars. But what is a star? A star is a gigantic ball of hot, luminous gases. If the gases are very hot, or if the star is very large, then the star is very luminous – it emits a lot of energy, and so it emits a lot of light. If the gases are not very hot, or if the star is not very large, then the star is not very luminous – it only emits a little energy, or light. So, the luminosity of a star, or the amount of energy it emits, is a product of the heat of the star's gasses and the size (dimensions) of the star. How do you say *heat* in English? Watch and listen: *It is hot out. I can't take this heat!* Is it clear? Let's continue....

To our eyes here, on Earth, there are stars that seem to shine a lot and others that seem to shine only a little. The stars that seem to shine a lot are not always the truly brightest stars. Look at me. (I get up on a chair.) I seem to be very tall, like a giraffe or my husband, Mr. Swaim. [Most of my students have met my husband, and often comment on the fact that he is a foot taller than I am!] But in fact, I am not very tall. I got up on a chair, that's all. In fact, I am not tall, I am kind of short, like Alexia [any notoriously short person in the class] or (some short celebrity). So, for the stars that seem to shine a lot, maybe they really do shine a lot, or maybe they shine only a little, but because they are very near to the Earth, they **seem** to shine a lot.

Lesson Starter: Les Étoiles brillantes et les étoiles faibles / Bright Stars and Dim Stars

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This section picks right up from where the previous cliffhanger left off, by explaining why a star that seems bright might not actually be bright. More vocabulary is introduced, and students will be able to refer to apparent or intrinsic magnitude or brightness. Number concepts are introduced with the concept of magnitudes. Making a chart on the board as these concepts are explained will be integral in conveying the relationships between distance, brightness, and measurements of magnitude. Although there are stars with negative magnitudes (including stars we are studying, like Sirius), for simplicity's sake we will refer to any star with a negative magnitude as a star of first-magnitude. Do explain that a very bright-looking star, like Sirius, actually has a magnitude of -1.6.

As an end to this lesson, you may choose to spend some time using transparency sheets and identifying which stars are of which magnitude; it is a great opportunity for choral repetition and to drive the idea of magnitudes home to students. When the constellations are taught, be sure to identify the magnitudes of the stars within them.

En français: Il y a les étoiles brillantes et les étoiles faibles. Si une étoile a une grande luminosité intrinsèque, c'est qu'elle émet beaucoup d'énergie, beaucoup de lumière. Comme nous connaissons, la luminosité intrinsèque d'une étoile est un produit de la chaleur des gaz de l'étoile et des dimensions de l'étoile. Mais l'éclat apparent, l'éclat que nous pouvons voir, ou percevoir, de la Terre, est un produit de la luminosité de l'étoile et de la distance de l'étoile à la Terre. Donc, l'éclat apparent dépend de la luminosité intrinsèque de l'étoile et de la distance de l'étoile à la Terre; la luminosité intrinsèque dépend de la chaleur des gaz et des dimensions de l'étoile. L'éclat apparent est ce qui est apparent à nos yeux.

Donc, les étoiles qui semblent les plus brillantes ont un grand éclat apparent, et les étoiles qui semblent les plus faibles ont un petit éclat apparent. L'éclat apparent s'appelle la magnitude. Curieusement, on dit qu'une étoile avec une magnitude brillante est de première magnitude, ou de magnitude un, et qu'une étoile avec une magnitude très faible est de cinquième magnitude, ou de magnitude cinq. Les étoiles brillantes et les étoiles très brillantes s'appellent les étoiles de **première** magnitude. Les étoiles assez brillantes s'appellent les étoiles de deuxième magnitude, ou de magnitude deux. Les étoiles de moyen éclat s'appellent les étoiles de magnitude trois; les étoiles faibles sont de quatrième magnitude; et les étoiles très faibles sont de cinquième magnitude.

Les étoiles de première magnitude sont les étoiles qu'on peut regarder **premièrement**, parce qu'elles sont les plus brillantes à nos yeux. Parce que la magnitude apparente s'agit aussi de la distance de l'étoile à la Terre, c'est possible pour une étoile qui est vraiment faible à posséder une magnitude du premier degré (si l'étoile est très proche à la Terre.) Aussi, c'est possible pour une étoile qui est vraiment brillante à posséder une magnitude du quatrième degré (si l'étoile est très loin de la Terre.)

English Translation: There are bright stars and dim stars. If a star has a great intrinsic luminosity, it is that it emits a lot of energy, a lot of light. As we know, a star's intrinsic luminosity is a product of the heat of the star's gases and its size. But apparent brightness, the brightness we can see, or perceive, from the Earth, is a product of the star's luminosity and the star's distance from the Earth. So, apparent brightness depends on the star's intrinsic luminosity and the star's distance from the Earth; intrinsic luminosity depends on the heat of the gases and the size of the star. Apparent brightness is what is apparent to our eyes.

So, the stars that seem the brightest have a great apparent brightness, and the stars that seem the dimmest have a small apparent brightness. Apparent brightness is called magnitude. Curiously, you say that a star with a bright magnitude is of 1 st magnitude, or of magnitude one, and that a star with a very weak magnitude is of 5 th magnitude, or magnitude five. The bright and very bright stars are called stars of **first** magnitude. Stars that are rather bright are called stars of second magnitude, or magnitude two. Stars of medium brightness are called stars of magnitude three; weak stars are of fourth magnitude; and very weak stars are of fifth magnitude.

Stars of first magnitude are the stars that you can see **first**, because they are the brightest to our eyes. Because the apparent magnitude is also a matter of the distance from the star to the Earth, it is possible for a star that is truly weak to possess a magnitude of the first degree (if the star is very close to the Earth.) Also, it is possible for a star that is truly bright to possess a magnitude of fourth degree (if the star is very far from Earth.)

Les 20 étoiles les plus brillantes / The 20 Brightest Stars

The chart in Appendix B lists the 20 brightest stars, or more accurately, the 20 stars that look the brightest to our eyes here on Earth. Each heading is written in the form of an incomplete sentence that is easily completed by entering the information listed below it. The progression from left to right, of the information in the chart, is as follows. In the first column is a hierarchy of brightness, from 1 ière , being the brightest, to 20 ième , being the least bright, of the twenty stars listed. The second column lists each star's name in French; the third and fourth column give, respectively, the name, in French and then English, of the constellation in which the star can be found. In the fifth column is the color of that star (as determined by internal temperature of the star), and in the sixth is the amount of light-years away from the Earth the star is located (rounded to the nearest light-year). Students will need a mini-lesson on colors, to practice using the suffix *–âtre* to convey *–ish*, as in bluish (bleuâtre) and whitish-yellow (**jaune** blanchâtre, and not the other way around.) The information in this section can be taught partway through the proceeding section on constellations, to break things up a bit.

Les Constellations (The Constellations)

This unit will introduce 11 constellations and 2 asterisms. All of them can be pretty easily seen in January, when the unit will be taught. Here are the constellations we will study: The Twins (les Gémeaux), Orion, the Big Dog (le Grand Chien), the Little Dog (le Petit Chien), the Charioteer (le Cocher), the Bull (le Taureau), Cassiopeia (Cassiopée), Cepheus (Céphée), Andromeda (Andromède), the Whale (la Baleine), and Great Bear (la Grande Ourse). We will also study the Big Dipper (la Grande Louche) and the Little Dipper (la Petite Louche), which are 2 asterisms that are visible all year long. Constellations to be studied were chosen by taking into consideration not only the best times of year to see them, but also the apparent brightness of some or all of the stars that make up the constellations (so that students have a chance of spotting them if they try), as well as the appeal of the "pictures" formed by the constellations, and the stories that relate one constellation to the other. [4]

I highly recommend creating your own version of the illustrations Rey made for his books. Printable overhead transparency sheets will work well for this. You can design the framework for the constellations (the star-dots) on the computer, using different-sized stars to represent the different magnitudes (be sure to include a key); then you can print another file that has only the imaginary lines you would use to connect-the-dots that will make an image out of the stars. You can begin like Rey does in *Find the Constellations*, by showing the star-dots and naming the constellation; then you can place the connecting-lines sheet over the star-dots sheet and label different parts of the image, like the handle and bowl of the Big Dipper. By working back and forth and alternating with and without the overlay, you can ease students into being able to identify the images with out the connecting-lines. Like Rey (on pages 18-19 and 22-23), I recommend creating different little mini quizzes to assess comprehension. First, give a sheet of the star-dot images *with* the connecting-lines, later, one of the images *without* connecting-lines; for each sheet, instruct students to provide the appropriate constellation names. For a more advanced quiz, rotate the star-dot images on the sheet, so that students must determine correct orientation of the image to identify it correctly.

Below I give some particulars on the stories behind each constellation, as well as information about the stars.

There are many ways to transmit this information, a few of which will be shown in the Lesson Plans section of this unit. For notable stars in each constellation I give a color, which can be incorporated into the artistic renderings of the constellations. The other stars should not appear as remarkable as these; they should be more neutral in appearance. However, since they will be smaller in size to represent the difference in magnitude, they can be somewhat colorful; their size will not allow the color to stand out well anyway. The quantity of stars of each magnitude is given for each constellation so that you may be sure to provide enough supplies for students to create artistic renderings of the constellations.

Les Gémeaux / The Twins

The Twins lie in the zodiac, the band of sky through which the Sun seems to move. It follows the line of the ecliptic, which is the path that the Earth travels as it revolves around the Sun. In astrology, when it is said that someone is a Gemini, it is meant that when that person was born, the Sun looked as if it was in front of the Gemini constellation, or the area of sky represented by the Gemini constellation. [5]

Rey says that the Twins look like "two matchstick men holding hands," and I think that says it perfectly! The two brightest stars of the constellation are named after the twins, Castor and Pollux, of Greek mythology; according to the myth, Pollux was immortal, Castor was not. When Castor was killed in battle, Pollux begged Zeus to bring him back to life; Zeus agreed to let Pollux share his immortality with his brother, but only in shifts so that, while one was alive, the other was "dead," in the underworld. It is said that through their constellation in the sky, they are finally able to be in the same place at the same time, together. In ancient times, people used to confirm oaths by saying "By Gemini," to prove their loyalty to the oath being taken. That phrase evolved over time into "By jiminy," and then become personified in the Disney character, Pinocchio's friend Jiminy Cricket.

Castor seems to be a single star of magnitude 1.6; it is actually a multiple star, made up of 6 different stars with magnitudes ranging from 1.9 to 9.0. For our purposes, we will treat it as a star of magnitude 2 (1.6 rounded up). The Castor stars are located 50 light-years away. Pollux is the 16 th brightest star in the sky; it has a magnitude of 1.2, which we will round to 1. It is located 34 light-years away. It is yellowish-orange in color. The constellation is made up of 1 1 st -magnitude star (Pollux), 2 2 nd -magnitude stars (one of which is Castor), 4 3 rd -magnitude stars, and 11 5 th -magnitude stars. To find The Twins, first locate the Charioteer; the Twins are just east of him.

Le Cocher / The Charioteer

Some say the Charioteer is named after the mythical inventor of the chariot; others say it represents any generic chariot driver. It is shaped like an angular face under a pointed hat. A good way to associate this constellation's name with its image is that the sharp angles of the image created by connecting the star-dots make his face look tough, like the driver of a battle wagon, or chariot. His eye is the yellowish, 1 st -magnitude star Capella, which is located 42 light-years away. It is the 6 th -brightest star in the sky, and is 16 times as large as the Sun. The constellation is made up of 1 1 st -magnitude star (Capella), 2 2 nd -magnitude stars, 3 stars of 3 rd -magnitude, and 2 of 4 th -magnitude. To find Capella from the Big Dipper, start at the first star of its handle, and draw a straight line that follows past the bowl and continues down. You will see three faint stars that form the nose, and can then locate the rest of the stars that form the Charioteer's face.

Cassiopée, Céphée, Andromède, la Baleine / Cassiopeia, Cepheus, Andromeda, Whale

According to Greek myth Cassiopeia was the Queen of Ethiopia, Cepheus was King, and Andromeda was their daughter. The story of these three begins with a foolish boast by a very beautiful and very vain Cassiopeia. Some sources say she said that *she* was more beautiful than the sea nymphs, who were goddesses of the sea, some say that she said *her daughter* was more beautiful; either way, the goddesses did not appreciate being compared to mere mortals. Neptune, a powerful Sea God, sent a whale (some say a sea-monster) to destroy their domain; to stop the destruction, Cepheus was told to sacrifice their daughter, Andromeda. He agreed to do so, and chained her to a rock by the sea. Just as the whale was about to swallow her, the hero Perseus killed it, rescued Andromeda, and then married her; he is also represented by a constellation, but not one that we will study here. They are said to have flown off on Perseus' winged horse, Pegasus, who is also represented by a constellation not addressed here.

Cassiopeia is a bright constellation located close to the Little Dipper and its Pole Star. She is recognizable by the W shape she makes in the sky. The traditional way of illustrating constellation images often does not correspond very well to a decipherable image; the picture is symbolically drawn around the star points, with much liberty taken in the interpretation. As you can see from Rey's books, his illustration technique is more simplistic and easier to associate with a true image. Unfortunately, the Cassiopeia constellation is a bit troublesome in this regard. The traditional image shows a full figure of the queen, but the Rey version leaves us with something that you can try to pass off as a queen's throne, but that really looks like an angular image of her two breasts. I will show my students the traditional image, and will then show how, if you include another star, you can form the seat of her throne. I expect that some student will volunteer his own opinion, and though I will not deny that I can see it, I will make a point of not adopting it. The Cassiopeia constellation is comprised of 3 stars of 2 nd -magnitude, 2 of 3 rd- and 1 of 4 th -magnitude.

Cepheus is a much dimmer constellation than Cassiopeia (which should not necessarily be construed as a statement on the intelligences of man versus woman!) His constellation forms an image of a pointed hat atop a man's face, much like the Charioteer. Cepheus' face makes an inlet for his mouth; it is not as angular and "tough-looking" as the Charioteer's, since he is a King and commands, but does not participate in, war. The biggest difference between the Cepheus and Charioteer constellations is that Cepheus has a pigtail at the nape of his neck, like an aristocrat would. The Cepheus constellation is made up of 3 stars of 3 rd -magnitude, 8 of 4 th -magnitude, and 1 of 5 th . To find Cepheus from the Big Dipper, follow the line of the Pointers past the Pole Star; it will hit the top side of his hat, close to its point.

The Andromeda constellation shows the girl lying down, with the chain affixed to her wrist. At her bent knee is a small hazy spot known as the Andromeda Nebula. It is a galaxy, and the most distant object the human eye can see unaided. The constellation is comprised of 3 2 nd -magnitude stars, 1 3 rd -magnitude, 13 4 th -magnitude, and 2 5 th -magnitude stars. It is easiest to spot her by first looking for the three brightest stars in line at her foot, rear end, and head.

The Whale is very difficult to spot, as all its stars are dim except for the one at his mouth. If you follow Andromeda's head-star diagonally down towards the left, you can spot the whale's mouth. It will be a fun challenge to see who can spot this one! The mouth is a 2 nd -magnitude star, there is 1 star of 3 rd -magnitude, and 12 of 4 th -magnitude. The Whale is also known as Cetus or the Sea Monster.

If you draw a straight line westward from Capella in the Charioteer, a straight line southward from the Pole Star, and look in the northwest quadrant formed by the intersection of those lines, you should see the upright

W of Cassiopeia. Just northwest of Cassiopeia is Cepheus, facing her sideways, the point of his cap across from the east-most top of her *W*. Just southwest of Cassiopeia is Andromeda, lying flat, the bright star of her rear end just south of the west-most top of her mother's *W*. Along the same line, but further south, is the star at the mouth of the Whale.

Orion

Orion is one of the most recognizable constellations in the sky. He is named after an ancient Greek hunter-warrior; there are many different myths about him, across cultures and continents. In his constellation image, he carries a shield in his left hand, and holds a club over his head with his right; he's also got a sword hanging at his hip. (Designations of left and right are given according to the constellation, so that Orion's left hand will be the hand we see on his right side if we are looking at him.)

Orion has more bright stars than any other constellation. Rigel and Betelgeuse are 1 st -magnitude stars – Rigel is bluish-white and the 7 th brightest star in our sky, and Betelgeuse, reddish, is the 10 th brightest. Rigel is 33 times the diameter of the Sun, which classifies it as a giant star (any star with a diameter between 10 and 100 times that of the Sun). Betelgeuse is a supergiant because, with a diameter 400 times greater than that of the Sun, it easily meets the supergiant requirement of having a diameter of over 100 times the Sun's. Although Betelgeuse is so much larger and closer than Rigel, it does not appear as bright because Rigel is hotter. Towards the bottom of his sword is a star that looks kind of fuzzy; it is actually a luminous gas-cloud called the Great Orion Nebula.

Rigel is located at Orion's left foot, Betelgeuse at his right shoulder. The constellation is most recognizable by the three closely-spaced bright stars of his belt. He is located just south of the Twins. The Orion constellation is comprised of 2 1 st -magnitude stars (Rigel and Betelgeuse), 5 stars of 2 nd -magnitude, 4 of 3 rd , 9 of 4 th , 6 of 5 th , and 1 nebula.

Le Grand Chien et Le Petit Chien / Big Dog and Little Dog

Big Dog and Little Dog are Orion's hunting dogs. Big Dog is located just southeast of Orion, and Little Dog is north of Big Dog. As the Earth rotates, it looks like these dogs follow Orion across the sky. The brightest star in our sky, a bluish 1 st -magnitude star named Sirius, is located in the Big Dog constellation. Sirius is actually a double star; it has a twin (named Sirius B) that is so faint it can only be seen with a large telescope, during ideal viewing conditions. It is fairly close to us, at a distance of 9 light-years. Almost as close as Sirius is Procyon, at a distance of 10 light years; it too is a double star. Procyon, the 8 th brightest star in our sky, is one of the two visible stars that make Little Dog; the constellation is nothing more than a small line, at best representing a pup's tail. *Procyon* is Greek for *before the dog*; it rises about 40 minutes before Sirius, which is known as the Dog Star. Big Dog is made up of 1 1 st -magnitude star (Sirius), 4 2 nd -magnitude stars, 2 3 rd -magnitude stars, 5 4 th -magnitude stars and 1 5 th -magnitude star. Little Dog is made up of 1 1 st -magnitude star (Procyon) and 1 3 rd -magnitude star.

Le Taureau / The Bull

Like the Twins, The Bull lies in the zodiac. It is best known for the Pleiades, a small cluster of tiny stars that looks like a little silver cloud. Six of its stars are visible to the naked eye, although there are about five hundred within the cluster. The Pleiades are nicknamed the Seven Sisters; it is possible that in the past a seventh star was visible without telescopes, and some myths tell of a lost sister to account for the missing

seventh star. Also noteworthy in this large constellation is Aldebaran, the 13 th brightest star; it is a 1 st -magnitude star, orangish-red in color, and represents the bull's eye. The bull's hindquarters are dimmer than its large head; Greek myth says that it is because the bull is really Zeus in disguise, swimming, his legs under water. The Bull is composed of 1 1 st- magnitude star (Aldebaran), 1 2 nd -magnitude star, 2 of 3 rd -magnitude, 15 of 4 th -magnitude, 3 of 5 th , and a cluster of tiny stars collectively called the Pleiades.

La Grande Louche, la Petite Louche, et la Grande Ourse / The Big Dipper, the Little Dipper, and Great Bear

What about the Dippers? Because of their popularity, I expect some students to be asking about the Dippers, wondering why we aren't discussing the Big or Little Dipper. Leaving them for last is purposeful, as we will need to introduce the idea of an asterism as opposed to a constellation. This will be easier after taking the time to discuss so many constellations. I also want to get students to ask for them, to tap into that desire for more.

Contrary to popular belief, the Big Dipper is not a constellation; it is an asterism. An asterism is a pattern formed by a part of an established constellation that doesn't appear on the official list of 88 constellations. The Big Dipper is that large, ladle-shaped image in the sky; the tip of its handle forms the snout of the Great Bear, and the bowl of the ladle forms a kind of saddle across his back. The outer edge of the bowl, or the back end of the saddle, is formed by two stars, called the Pointers; if you follow their slight curve, they will point you toward the Pole Star (the only bright star in that area, so easy to spot.)

The Pole Star, also known as Polaris and the North Star, is located at the very top of the Little Dipper's handle. No matter where you are, if you are facing the Pole Star you are facing north; it changes position so little in the sky that we can say it does not change at all. For a better explanation of why this is so, see the next section of this unit, entitled *The Pole Star and Changing Sky Views*. In the Northeast, The North Star will lie about halfway between the horizon and the point directly overhead (called the zenith).

The Little Dipper is also an asterism. It is part of the Little Bear constellation, but because the other stars of that constellation are very faint, we will content ourselves with looking for only the Little Dipper, and not Little Bear. The two stars that form the outer edge of its bowl are called the Guardians of the Pole, because they seem to march around the pole, like guardians.

The Pole Star and Changing Sky-Views

If you spend some time stargazing one night, you will see the stars move across the sky. Really, the stars just seem like they're moving; it is actually the Earth that moves, by spinning on its axis. As the Earth spins, its "nighttime" side slowly turns towards different portions of the sky, so different stars are visible at different times. (Of course, the other side of the Earth is facing the Sun, and daytime.) It takes the Earth 4 minutes short of 24 hours to get back to the same spot of nighttime sky, and the same constellations; so each star is said to set 4 minutes earlier than it did the previous night.

When a star comes up in view above the horizon, we say that it is rising; when it goes down and out of view below the horizon, we sat that it is setting. Just like the Sun and the Moon, the stars rise in the east and set in

the west. The Pole Star stays virtually in the same spot in the sky, more or less at the pole of the sky; all the other stars seem to revolve around it in circles. On pages 22-23 of Rey's *The Stars*, there is a great activity using an umbrella to demonstrate the way the stars seem to rotate around the Pole Star. You would designate the tip of the umbrella as the Pole Star, and draw the constellations around it, on the fabric of the umbrella. If you can find a really large umbrella, you can have students walk around underneath it, to show how the stars actually remain fixed; in this case, the walking student would represent the Earth.

Six constellations are located close to the pole, and as such will always appear above the horizon; that means they are always visible. Called circumpolar constellations, they are Great Bear, Little Bear, Cassiopeia, Cepheus, Dragon, and Giraffe.

Papier ou 3-D? / Paper or 3-D?

Here we have the English language content component to Lesson Plan 1, of the same name. It works in conjunction with the previous section, as it helps us understand the changing sky-views as we stress the move from two- to three-dimensional space.

What is a constellation? A constellation is a group of stars that can be seen in the sky at night. To our eyes, these stars seem to form drawings in the sky, as if the sky was flat, like a sheet of paper, and someone drew little pictures on the paper of the sky. Of course, we know that the sky is not flat, because we know that the Earth is not flat. The Earth is a three-dimensional sphere, like a big ball. A sheet of paper is only a two-dimensional object. Like the Earth is a three-dimensional sphere, the gas which is all around the Earth, called the atmosphere, is also three-dimensional.

Here is the Earth. [I show a football.] Here is the atmosphere. [I place a big piece of cotton around the ball.] And these are the stars in the atmosphere. [I put some sequins in the cotton.] Although it seems that each constellation is made on a flat surface, in reality that is not the case. In reality, maybe there was one star here, another star here, and another over there. [I place each "star" at a different depth.] To our eyes, all these stars seem to form a two-dimensional, flat surface, but we know that it is truly a three-dimensional space.

[I place a basketball on a stick, and the stick in a bucket filled with sand, for stability.] Here is the Sun. Look how it stays in the same place. Look how the Earth revolves around the Sun. It doesn't make a circle, like this; it makes an oval, like this. A single trip around the Sun takes how many days? [I wait for an answer; if there is no answer, I give it.] It takes 365 days. We have different seasons during the year, because the light from the Sun strikes more directly the hemisphere, and so is more concentrated in the summer, and in the winter, less concentrated, so less strong. [I show the Earth's trip, using a photo like what can be found on page 121 of the book *The Stars* by H.A. Rey as a guide.] Just like the seasons change during the year, the views of the stars that can be seen also change during the year. Watch: Here is the Sun, the Earth, and over there are the planets of our solar system. The stars that can be seen are over here, on this side of the Earth. There are also stars on this side, but we can not see them, because of all the light from the Sun. Stars are fixed; the Earth is not fixed. The Earth moves, the Earth travels; the stars don't move, don't travel. In fact, stars move a very very little bit, over the course of many many years; it is a negligible movement.

Light Years

A light-year is the distance that light travels in one year. Light travels 186,000 miles a second, which is almost six million million miles, or six trillion miles (6×10^{12}). With all those zeros, it would be really easy to make a mistake in reading the distances. So the light year was created to make the numbers more manageable. The chart in Appendix B gives the distance in light years that each star is from the Earth. That distance, combined with the star's intrinsic luminosity determines how bright the star seems to us on Earth.

See *Lesson Plan 2 – Les Années-lumières / Light Years*.

Activities

There are endless wonderful activities that can be done around this unit. To practice and self-assess vocabulary, students can make flash-cards for all vocabulary, with the French word on one side and an image (photo, drawing, collage, etc.) of the item on the other. For students who insist that they either can't draw, are not artistic, or will simply learn better with just the English word on the back, you may have them either cut different letters out to create the word, or artistically write the word, with mnemonic clues; the point is to get students actively creating the cards so that more thought goes into their use. Students can use short periods of specified class time, as well as transition time, to either quiz each other or quiz themselves. I am continually amazed at how much students enjoy doing this!

You may have students create their own fill-in-the-blank sky scenes, sky view charts, individual constellations, or magnitude charts for other students to complete; be sure to remind students to make an *answer key* and not to write the answer *in* the blanks themselves! Of course you may create your own, but a student is rewarded for a job well done when another student gets the opportunity to complete his/her sheet. If a student does not complete the initial creation assignment (usually a homework assignment in my class), I have that student create it in class, but he/she either has to complete two sheets instead of one, or else that student does not get the opportunity to share it with a classmate or to complete one from a classmate. If this student does an exceptional job in class, I will photocopy it so that the whole class can do it for the following evening's homework, which encourages the student to do the job right (if this were to happen again I would not send the sheet to any students, as then it would become a reward for not doing the assignment the first time.)

Questioning Techniques

There are many different levels of questioning techniques to utilize as students advance through comprehension. Below are samples of several effective techniques.

Comment dit-on?

For simple vocabulary recall

Comment dit-on **étoile** en anglais?

Comment dit-on **star** en français?

(How do you say blank in this-or-that language?)

Oui ou Non?

For basic comprehension check

Une étoile de première magnitude est faible, Oui ou Non?

Une étoile de première magnitude est brillante, Vrai ou Faux?

(A first magnitude star is weak, Yes or No?)

(A first magnitude star is bright, True or False?)

Je m'appelle...?

For mid-level comprehension check

Je m'appelle Sirius, je suis une étoile dans la constellation_____?

(My name is Sirius, I am a star in the ___ constellation?)

Qui suis-je?

For advanced comprehension check

Je suis une étoile brillante dans la constellation Le Grand Chien. Qui suis-je? (I am a bright star in the Big Dog constellation. Who am I?)

Lesson Plans

Lesson Plan 1 – Papier ou 3-D?

Duration: 1 50-minute class period

Objectives: To define a constellation, to describe the difference between the constellation images we have drawn and the way the stars actually exist in the sky, to practice taking notes, to illustrate the way the sky-view changes over the course of a year.

Materials: Chart paper, blue, orange, and green markers, sheets of paper and a plate, a globe, a can of aerosol hairspray (CFC-free, of course!), a soccer ball, a large piece of cotton (to cover the ball), sequins, a basketball (with a hole cut out of the bottom so that it can be placed on a stick), a stick, a bucket filled with

sand.

Do Now! Assignment: Dessinez votre constellation préférée. Nommez-la en français. Expliquez pourquoi c'est votre constellation préférée, en français, ou en anglais si c'est absolument nécessaire.

Initiation: Collect *Do Nows!* Ask students this question: *Qu'est-ce que c'est une constellation?* Make a key-word list of the responses, repeating English answers in French, and writing key-words in French. After all responses are given, go through each one and write a star if it is correct, or cross it out with a squiggly line if it is incorrect (I find squiggly lines to be less accusatory than plain strikethroughs!) When an answer is close, correct the inaccuracy. One color marker should be used for the list (I prefer blue, as it is easy on the eyes but not plain old black), another for the correct markings, including whatever you add to make something correct (I like upbeat pink or orange), and another for strikethroughs (I prefer less-harsh green.)

Activity: In this lesson, the teacher explains content and asks for responses to check for understanding. The content should be spoken slowly and emphatically, using TPR-type gestures and movements, so that someone walking past the room might think that the teacher was engaged in some sort of spoken mime routine!

Une constellation, c'est un groupe d'étoiles qu'on peut voir au ciel quand il fait nuit. ¿ nos yeux, ces étoiles semblent à former les dessins au ciel, comme si le ciel était plat, comme une feuille de papier, et quelqu'un a dessiné des petites images sur le papier du ciel. Bien s—r, nous connaissons que le ciel n'est pas plat,

parce que nous connaissons que la Terre n'est pas plate. La Terre, c'est une sphère en trois dimensions, comme une grande balle. Une feuille de papier, c'est un objèt en seulement deux dimensions. Comme la Terre est une sphère en trois dimensions, le gaz qui est tout autour de la Terre, ce qui s'appelle l'atmosphère, est aussi en trois dimensions.

The sheets of paper and the plate can be used to make a connection between flat, *plat*, and a plate. I like to combine English and French to helps students remember cognate connections, as I would here by touching different flat surfaces and repeating this phrase, "C'est plat(e) comme *a plate*." I would use the aerosol can of hairspray when discussing the atmosphere because many of my students use it in their hair, and it will help them to start to visualize what the atmosphere might be like, as it surrounds the Earth. I will stress the difference between the moment when the spray first comes out and you can see it, and a few seconds later, when it has dissipated into the air. Although you can not see the atmosphere, it exists.

- Questions (Answers are in bold-type): Est-ce que le ciel est plat? **Non.** Est-ce que la Terre est plate? **Non.** La Terre, c'est comme **une balle** ou comme un feuille de papier? Le ciel, c'est en deux ou **trois** dimensions? Une constellation, c'est **une groupe d'étoiles** ou une groupe de balles? Une constellation, c'est **une groupe d'étoiles** ou **une groupe de dessins**?

Voilà la Terre. [Je presente un ballon de football.] Voilà l'atmosphère. [Je mets un grand morceau de coton autour du ballon.] Et ce sont des étoiles dans l'atmosphère. [Je mets des paillettes dans le coton.] Bien qu'il semble que chaque constellation est faite sur une surface plate, en réalité, ce n'est pas le cas. En réalité, peut-ítre qu'il y avait une étoile ici, une autre étoile ici, et une autre là- bas. [Je mets chaque "étoile" à une profondeur différente.] ¿ nos yeux, toutes ces étoiles semblent à former une surface plate, en deux dimensions, mais nous connaissons que c'est vraiment une éspace en trois dimensions.

- Questions: Où est la Terre? Où est l'atmosphère? Où sont les étoiles? Devinez, où est le Soleil? Touchez-les.

[Je mets un basket-ball sur un baton, et le baton dans un seau rempli du sable, pour la stabilité.] Voila le Soleil. Regardez comme il reste à la meme place. Regardez comme la Terre tourne autour du Soleil. Elle ne fait pas un cercle, comme ça; elle fait un ovale, comme ça. Un seul voyage autour du Soleil prend combien de jours? [J'attends une réponse; s'il n'y a pas de réponse, je la donne.] Il prend 365 jours. Nous avons les saisons differentes pendant l'année, parce que la lumière du Soleil est plus concentrée et donc plus forte, en été et, en hiver, moins concentrée, donc moins forte. [Je montre le voyage de la Terre, en utilisant un photo comme ce qu'on peut trouver à page 121 du livre *The Stars* de H.A. Rey comme guide.] Juste comme les saisons changent pendant l'année, aussi les vues d'étoiles qu'on peut voir changent pendant l'année. Regardez: Voilà le Soleil, la Terre, et là-bas ce sont les planètes de notre système solaire. Les étoiles qu'on peut voir sont ici, a ce c"té de la Terre. Il y a des étoiles à ce c"té aussi, mais nous ne pouvons pas les voir, à cause de toute la lumière du Soleil. Les étoiles sont fixées; la Terre n'est pas fixée. La Terre bouge, la Terre voyage; les étoiles ne bougent pas, ne voyagent pas. En fait, les étoiles bougent un très très petit peu, au cours de beaucoup beaucoup d'années; c'est un mouvemente négligeable.

- Questions: Est-ce que les étoilents bougent? **Non.** Est-ce que la Terre bouge? **Oui**. Est-ce que la Terre est fixée? **Non.** Est-ce que les étoiles sont fixées? **Oui**. Est-ce que la Terre fait un cercle autour du Soleil? **Non, un ovale**. Est-ce qu'il y a des étoiles entre le Soleil at la Terre? **Oui**. Est-ce qu'on peut les voir? **Non.** Pourquoi? **¿ cause de la lumière du Soleil.** La Terre prend combine de jours pour voyager autour du Soleil? **365**.

Closure: Ask each student to stand and share one fact he/she learned today. If a child can not say a full sentence, encourage him/her to say as much as possible, and fill in the blanks as needed. For homework, students will make an illustration of how the star-views change over the year, labeled in French.

Lesson Plan 2 – Les Années-lumière

Duration: 1 50-minute class period

Objectives: To define a light year, to make comparisons between distances of stars and magnitudes, to calculate differences between distances, to draw conclusions about the relationship between magnitude and distance.

Materials: Chart of the 20 Brightest Stars, from Appendix B (students will already have theirs) choice cards with the names of each star on the list, bucket for the cards, turn-taker (small bean-bag animal passed to students to take turns), transparency sheet of just columns 1,2, and space for column 6, of the chart (star hierarchy, name. and space to fill in distance from the Earth), list of questions to ask to compare and calculate distances, and copies (without answers) for students.

Do Now! Assignment: Copiez la phrase suivante: *Une année-lumière = 6,000,000,000,000 miles,* Traduisez-la en anglais.

Initiation: Ask for translations, to see who understands a number of that size; write down all guesses, so that, if there are many, it will reinforce the idea that the light-year needed to be invented. If they know the number easily, I will just praise them for being *super-intelligent* and get them to concede that the light-year is easier. Explain that a light-year is a distance and not a measure of time (the distance the light travels in a year's time.)

Activity: Begin the activity with choral repetition of the chart's information, according to the following model.

Sirius est l'étoile la première plus brillante dans le ciel. Elle se trouve 9 années-lumière de la Terre. Then ask fill-in-the-blanks questions to practice the numbers with the same information, as in, *Sirius est l'étoile la _____ brillante dans le ciel. Elle se trouve ___ années-lumière de la Terre.* Pass the choice card bucket around; the student needs to say, in as full a sentence as possible, where that star stands on the hierarchy of brightness, as in, *Sirius est l'étoile la première brillante dans le ciel*. The student to that student's left then says how far that star is from the Earth, in light-years; then he/she throws the turn-taker to someone else. Repeat the cycle until everyone has gone at least once. Go to the transparency sheet and have students give the light-year distances from their sheets; fill them in on the transparency. Using your list, ask word problem questions like: *Canopus est 313 années-lumière de la Terre, et Arcturus est 37 années-lumière de la Terre. Quelle est la différence entre les deux distances?276 al.* [The abbreviation for *années-lumière* is *al.*] *Quelle étoile est plus proche? **Arcturus.***Quelle étoile est plus brillante? **Canopus.** Pourquoi?**Canopus a une plus brillante magnitude, elle a une plus grande luminosité intrinsèque qu'Arcturus.** Do several as a class, and then break down into groups of two. Pass out question sheets and pairs take turns asking and answering the questions, as the teacher monitors.

Closure: Ask students to define a light-year. Ask students why Arcturus is so much closer than Canopus, yet it is less bright than Canopus. For homework, students should choose 1 word problem we did in class, and illustrate it, with labels, distances, vocabulary, and detail.

Lesson Plan 3 – Créez une Constellation!

Duration: 3 50-minute class periods

Objectives: To examine the constellations we have learned in order to assess characteristics of a constellation, to name a "new" constellation using that criteria, and to construct a two- and a three-dimensional model of that constellation.

Materials: Transparency sheet made up to be a General Sky Chart (like the one on the last page of Rey's book *Finding the Constellations*). The transparency sheet will have different-sized pin-holes to represent the stars; first run the sheet through a photocopier with no image to be copied to make the sheet black, so that the light shining through the holes will show up like stars in the night sky. If possible, get an old wall projector so that the image can be as large as possible on the wall, as if you were going to trace the images on a roll of newsprint. Craft supplies, including things like sequins and beads of different sizes for stars of different magnitudes; a selection of papers, pipe cleaners, thread, buttons, bottle caps, extra pencils, an easel or masking tape, chart paper, markers, index cards, voting ballot sheets.

Pre-Class Preparation: Last night's homework assignment will have been to scavenge the house for craft items to make a constellation model out of. Students will know that they will be making one two-dimensional model and one three-dimensional model, and we will have brainstormed a possible materials list already. Students will also have already replicated their own General Sky Chart, and should have it with them.

Do Now! Assignment: Regardez votre Feuille de Ciel. Cherchez une autre image, une nouvelle image, à créer avec les étoiles. Essayez de joindre des nouvelles étoiles!

Initiation: Turn on the overhead projector, and ask for volunteers to show their "new" constellation possibilities. Students may need longer, and they will have more time during class. I will be prepared with one far-out example (so as not to "take" an apparent idea!) to show them.

Activity: Ask students to give characteristics of a constellation, and make a chart of them (you will need an easel or tape since this list should remain up and there is a Sky Chart occupying your blackboard!) Once we all agree on the characteristics (including stars of different magnitudes and distances, possibility of creating an image from the star-dots in the sky, and constellation myths), students will go back to work on finding a "new constellation." When each student is done, he/she may get out his/her supplies from home, and begin to plan and then create the two-dimensional representation of the constellation (including an index card with constellation name, names of noteworthy stars, and any corresponding information. As students finish the paper model, they will meet with me to explain what they've done and why. I will point out any areas of particular strength or weakness, and we will come up with suggestions for improving the weaknesses; inaccuracies will be corrected. After pitching its basic idea to me, the student will then be permitted to work on his/her 3-D model. At the end of the first day, students will be assigned to bring in any items that may be needed to finish the project. If a student is behind he/she will need to work at home this night. At the end of the second day, students will be assigned to finish the project for homework. On Day 3, students will share their constellations with the class.

Closure: At the end of Days 1 and 2, students will be asked to tell one thing that worked, 1 thing that did not work, and why. Students already know that when I ask these questions, answers could include knowledge that was recalled (or not), processes that went smoothly (or not), matters that needed clarification (or not), or ideas that were carried out as expected (or not). At the end of Day 3, we will place secret ballot votes for Most Creative Name, Most Creative Image, Most Scientific, Most Artistic, Most Witty, Most Accurate, and Best All-Around Constellations (for both 2-D and 3-D models). I will tally results to offer 1 st , 2 nd , and 3 rd place awards in each category. I will create quirky, funny awards for the small number of people who don't get an award; unless there is a strong atmosphere of caring and fun in the classroom, this could backfire and further stigmatize these children, so proceed accordingly. I will make award "buttons" on name-tag stickers for student-winners.

Annotated Bibliography

Freedman, Roger and William Kaufman. *Universe*, *seventh edition.* New York: W.H. Freeman and Company, 2005. This is a clearly written and hugely informative astronomy textbook that was integral to the writing of this unit.

Krupp, Dr. E.C. *Beyond the Blue Horizon: Myths & Legends of the Sun, Moon, Stars, & Planets*. New York: Oxford University Press, 1991. I used this collection of sky stories for basic information on the different myths behind the constellations.

Rey, H.A. *Find the Constellations*. Boston: Houghton Mifflin Company, 1982. The format of this unit is in part based on the format of this English language children's book on constellations and astronomy. The simple language is an ideal model to follow when teaching content in a foreign language, and there are great examples of how to "see" the constellations in the sky. One warning: The distances listed on page 67 for the "15 Brightest Stars" are erroneous, as since the publication of this book, the Hipparcus satellite has provided more accurate measurements than previously available. See Freedman and Kaufman, Appendix 5, for accurate measurements (which have been included in the chart I created of the 20 Brightest Stars.

Rey, H. A. *The Stars: A New Way to See Them*. Boston: Houghton Mifflin Company, 1997. Another great resource for this unit. The chart of the "21 Brightest Stars" replaces distance measurements with magnitudes, so it would be good information to use in demonstrating the different relationships between distance and apparent brightness.

Ridpath, Ian. *Eyewitness Handbooks: Stars and Planets*. New York: DK Publishing, Inc., 1998. An informative source for students and teachers, with many illustrations, including real images of the stars that make up the constellations, as they appear in the night sky.

Annotated Web Sources

About.com-French. http://french.about.com/library/weekly/bltopicsub-g.htm. A thorough online source for French grammar rules and help.

Active Learning Online. http://www.acu.edu/cte/activelearning/whyuseal2.htm. Image and explanation of Edgar Dale's *Cone of Learning*.

Astrofrance.net. **http://perso.wanadoo.fr/constellations/index.htm**. French language information on stars, constellations, and planets. Useful in finding the correct French accenting and translation for the star and constellation names.

Astronomy for Kids (and Supervised Adults). http://www.dustbunny.com/afk/index.html. Excellent comprehensive website for astronomy information, for kids but not kiddish. Lots of varied graphics and easy to navigate.

Ciel & Espace – France. http://www.cieletespace.fr/default.aspx. This site has gorgeous photographs of stars and the night sky. For advanced students, this site has a section entitled "Paroles d'Astronomes" in the larger section entitled "Comprendre". Here there are little video presentations of astronomers speaking about astronomical issues. In particular Hubert Reeves speaks clearly and fairly slowly, so that students have a best chance of comprehension with his presentations (of which there are 17).

Constellations. **http://perso.wanadoo.fr/simoes/christian/constellations.html**. This site has information on the colors of different stars according to their temperature. It seems to be a personal website, so double-check all information!

Constellations: Starshine.com. http://www.starshine.com/frankn/astronomy/ constellations.asp. This is a personal website that has a lot of information on it. Since it is not the site of an organization, I would only use this as a starting point for information to then research more carefully.

Factmonster. http://www.factmonster.com. Excellent site for children to look up information on stars.

Imago Mundi – Le ciel de la terre. http://www.cosmovisions.com/CTconstellations.htm

Great French language site, with thorough information on stars and constellations.

Mythography. http://www.loggia.com/myth/content.html. Good source for Greek myths about the constellations.

NASA KIDS. http://kids.msfc.nasa.gov. Lots of links from a very reputable source.

Planétarium de Montréal. http://www.planetarium.montreal.qc.ca/index_f.html. Montreal Planetarium website, in French and English. Great source of information, French language and spelling of content. Also, there is a 20-page classroom activity document on the solar system at the following part of the site: http://www.planetarium.montreal.qc.ca/Education/Fiches/PDF/roue_planetes.pdf.

WordReference.com. http://wordreference.com. Great multi-language dictionary site, with accurate and thorough translations or words and phrases. I recommend this site for students also.

Appendix A: Vocabulaire

Les Noms

année-lumière *f.* (light-year, pl. *les années-lumière*; light travels 6x10 ^{12} miles in one year)

astérisme *m.* (an asterism, a pattern formed by a part of an established constellation, that does not appear on the official list of 88 constellations)

chaleur *f.* (heat)

ciel *m.* (sky)

constellation *f.* (a constellation, or a group of stars that appear to form easily recognizable images in the sky)

constellations circumpolaires *fpl.* (the constellations surrounding the Pole Star, that are visible all night, all throughout the year)

dimensions *fpl.* (size, dimensions)

distance *f.* (distance)

éclat *m.* (brightness)

éclat apparent (apparent brightness, the modifier apparent helps to differentiate between brightness we can see and the intrinsic brightness of a star)

énergie *f.* (energy)

est *m.* (east); à l'est de (to the east of)

étoile *f.* (star)

étoile de première magnitude (a star of 1 st magnitude or magnitude 1, bright or very bright)

étoile de deuxième magnitude (a star of 2 nd magnitude or magnitude 2, rather bright)

étoile de troisième magnitude (a star of 3 rd magnitude, of medium brightness)

étoile de quatrième magnitude (a star of 4 th magnitude, faint)

étoile de cinquième magnitude (a star of 5 th magnitude, very faint)

gaz *mpl.* (gases)

lumière *f.* (light)

luminosité *f.* (luminosity, or rate of energy emitted by a star)

luminosité intrinsèque *f.* (intrinsic luminosity, the modifier *intrinsic* helps to differentiate between what is apparent to us and what is an intrinsic characteristic of the star)

magnitude *f.* (magnitude, a measure of a star's perceived brightness)

nébuleuse *f.* nebula

nord *m.* (north); au nord de (to the north of)

nuit *f.* (night)

ouest *m.* (west); à l'ouest de (to the west of)

Polaire *f.* (Pole Star, or North Star, part of the Little Dipper asterism and Little Bear)

queue *f.* (handle, for the Big and Little Dipper)

saisons *fpl.* (seasons)

Soleil *m.* (Sun)

sud *m.* (south); au sud de (to the south of)

Terre *f.* (Earth)

Les Adjectifs

beaucoup (a lot) —> un peu (a little)

brilliant-e (bright/brilliant) —> faible (dim/weak)

chaud-e (hot) —> froid-e (cold)

loin (far) —> proche (near)

lumineux, lumineuse-s (luminous)

plus (more) —> moins (less)

Les Verbes

briller (to shine); émettre (to emit); lever les yeux (raise your eyes/look up); percevoir (to percieve); regarder (to watch); se trouver (to be located); voir (to see)

Appendix B – Les 20 étoiles les plus brillantes

Table: Les 20 étoiles les plus brillantes

L'Hiérarchie de brilliance (1-20)	L'Etoile s'appelle...	Elle se trouve dans la constellation...	Qui s'appelle ... en anglais.	La couleur de l'étoile, c'est....	Elle est ... années-lumière de la Terre.
1 ière	Sirius	Le Grand Chien	The Big Dog	Bleuâtre	9
2ième	Canopus	La Carène	Carina (The Ship's Keel)	Blanche jaunâtre	313
3 ième	Arcturus	Le Bouvier	The Herdsman (Boötes)	Orange rougeâtre	37
4 ième	Alpha Centauri	Le Centaure	The Centaur	Jaune orangeâtre	4.
5 ième	Véga	La Lyre	The Lyre	Blanche bleuâtre	25
6 ième	Capella	Le Cocher	The Charioteer	Jaunâtre	42
7 ième	Rigel	Orion	Orion	Blanche bleuâtre	773
8 ième	Procyon	Le Petit Chien	The Little Dog	Blanche jaunâtre	11
9 ième	Achernar	L'Eridan	Eridanus, a river from Greek mythology	Blanche bleuâtre	144
10 ième	Bételgeuse	Orion	Orion	Rougeâtre	427
11 ième	Beta Centauri	Le Centaure	The Centaur	Blanche bleuâtre	525
12 ième	Altaïr	L'Aigle	The Eagle	Blanche jaunâtre	168
13 ième	Aldébaran	Le Taureau	The Bull (Taurus)	Rouge orangeâtre	65
14 ième	Spica	La Vierge	The Virgin (Virgo)	Blanche bleuâtre	262
15 ième	Antares	Le Scorpion	The Scorpion (Scorpio)	Rougeâtre	604
16 ième	Pollux	Les Gémeaux (les jumeaux)	The Twins (Gemini)	Orange jaunâtre	34
17 ième	Fomalhaut	Le Poisson Austral	The Southern Fish	Blanche bleuâtre	25
18 ième	Deneb	Le Cygne	The Swan	Blanche bleuâtre	3230
19 ième	Bêta Crucis	La Croix ou La Croix du Sud	The Cross or The Southern Cross	Blanche bleuâtre	353
20 ième	Régelus	Le Lion	The Lion	Blanche bleuâtre	78

Endnotes

1. Even with this enthusiasm, too much will turn students off, so I suggest using the Stars lesson starter to create the first day's lesson, then introducing a constellation or two the next day, and the third day using the Bright Stars and Dim Stars lesson starter to create a lesson that will use the previous day's constellations to illustrate what is introduced. Also: See **Appendix A – Vocabulary**, for a list of French-English vocabulary in the unit.

2. For an image and explanation of Edgar Dale's *Cone of Learning*, see the following website: http://www.acu.edu/cte/activelearning/whyuseal2.htm.

3. Unless otherwise noted, all science facts and information in this unit are taken and combined from Freedman (2005), Ridpath (1998), Rey (1982 & 1997), and the Imago Mundi website. I synthesized this information for each section and, where indicated, formed appropriate French language ways to communicate the information to middle school language learners, and then translated my French for the "English Translation."

4. For the Constellation section, myths are taken from Krupp, the Mythography website, and Rey (1982 & 1997). The quantity of stars of each magnitude is determined by counting the representations of stars of different magnitudes in the constellation images in Rey (1982).

5. Astrologists contend that this positioning means something in terms of human behavior and character; astronomers contend that it means nothing. To disprove the significance of astrology as a science, astronomers often cite precession, a process by which the gravitational pulls of the Sun on one side of the Earth and the Moon on the other cause the Earth to kind of wobble, like a spinning top, while it rotates; this wobbling results in a change in the position of the Earth's axis and through that, a change in the position of the celestial poles. For a clear picture of how this works, see Rey's *The Stars* (p. 129). For a concise article detailing some of the factual, scientific shortcomings and inaccuracies of astrology, see Freedman and Kaufman, page 41. This unit will address astronomy, and not astrology; although students may want to tell what they "know" about astrology, teachers should be clear and firm that astrology is not astronomy, that astronomy is a very debatable study, and that it is not a science as astronomy is.