

An tSraith Shóisearach do Mhúinteoirí

Junior **CYCLE** for teachers

**Learning Outcomes
in Action**

JCT Science Team

ISTA Conference 2017
NUI Maynooth



www.jct.ie

In this workshop, we use a series of activities to show how learning outcomes translate into classroom practice. In particular, we wish to highlight how consideration of the action verb in the learning outcome brings clarity to the expectations for the learning outcome in the classroom.

The front page of each activity gives the context of learning and identifies both the learning outcomes in focus and the learning intention for the activity as well as the prior learning of the students for whom these activities were developed.

These activities are presented in paper form here but are available as word documents on our website www.jct.ie where you could adapt them to suit your student cohort. The purpose of the activities is not to exemplify how these learning outcomes must be taught but rather to highlight how the action verb was considered in interpreting the learning outcome and in developing learning experiences for this cohort of students.

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Learning Outcomes in Focus

Contextual Strand: CW3

Students should be able to describe and model the structure of the atom in terms of the nucleus, protons, neutrons and electrons; comparing mass and charge of protons, neutrons and electrons.

DESCRIBE: Develop a detailed picture or image of, for example, a structure or process; using words where appropriate; produce a plan, simulation or model.

Nature of science: NOS1

Students should be able to appreciate how scientists work and how scientific ideas are modified over time.

Learning Intentions

- Students will be able to describe where sub-atomic particles are located in the atom and how the mass and charge of the different particles compare.
- Students will begin to develop a practical understanding of the limitations of models.

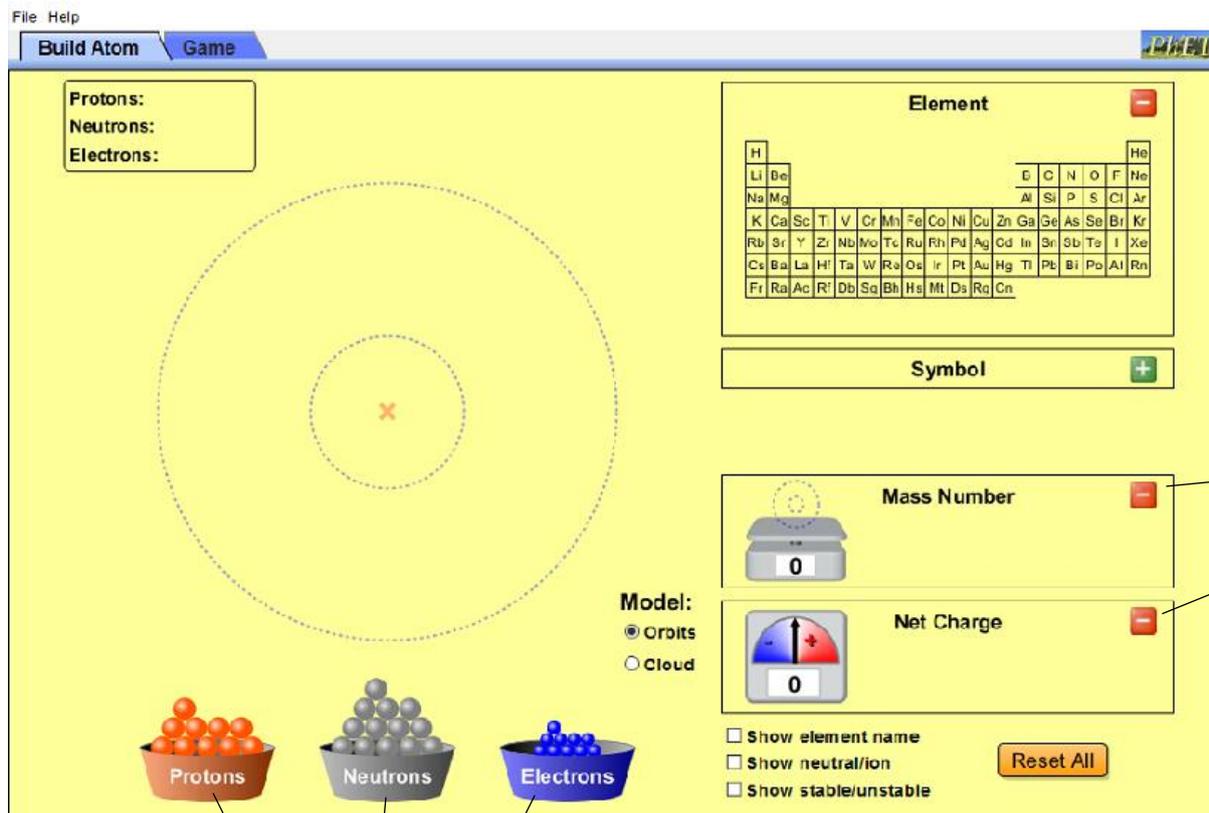
Prior Learning

Students have no prior knowledge of atomic structure but

- Understand that elements are made up of atoms
- Have covered the concept of mass

Student Activity Sheet.

Open the [pHet](#) “build an atom” simulation. Try the different buttons and then set up the simulation as shown in the diagram.



These are the three things that are inside an atom. They are called SUB ATOMIC PARTICLES.

We are going to use the simulation to find out

- Where the different sub-atomic particles are found in the atom
- Whether the sub-atomic particles have a charge
- Whether the mass of the sub-atomic particles contribute significantly to the mass of the atom.

- Using the simulation drag protons, neutrons and electrons into the atom. Use these words to complete the table:

PROTONS; NEUTRONS; ELECTRONS

	These particles are always found in rings around the outside of the atom.
	These particles are found in the centre (the nucleus) of the atom.

- Press reset. Place the indicated number of *neutrons* in the atom and fill in the table after each addition. Mass is indicated on the electronic balance. Charge can be positive or negative.

Number of neutrons	Mass number reading	Net charge reading
1		
2		
3		
4		

Look at your results and discuss in your group the answer to the following questions:

- What happens to the *mass* number reading when you add a neutron? What do you think will happen when you add another neutron? Check your answer.
- What happens to the *charge* when you add a neutron? What do you think will happen to the charge when you add another neutron? Does a neutron have any effect on the charge?

- Press reset. Place the indicated number of protons in the atom and fill in the table after each addition.

Number of protons	Mass number reading	Net charge reading
1		
2		
3		
4		

Look at your results and discuss in your group the answer to the following questions:

- What happens to the *mass* number reading when you add a proton? What do you think will be the mass number reading if you add another proton? Use the simulation to try.
- What happens to the *charge* when you add a proton? What do you think the charge will be if you add another proton? Does a proton have a charge?

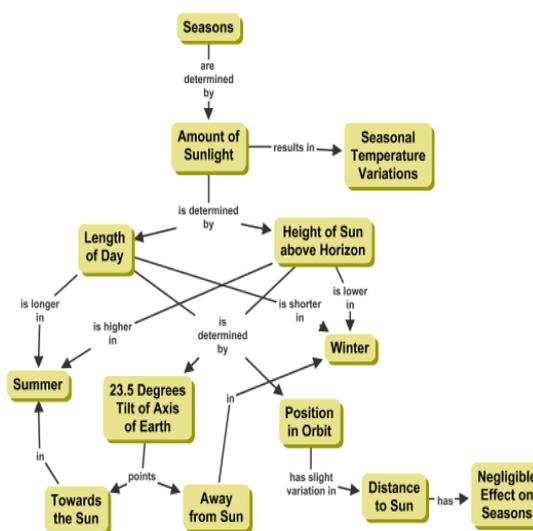
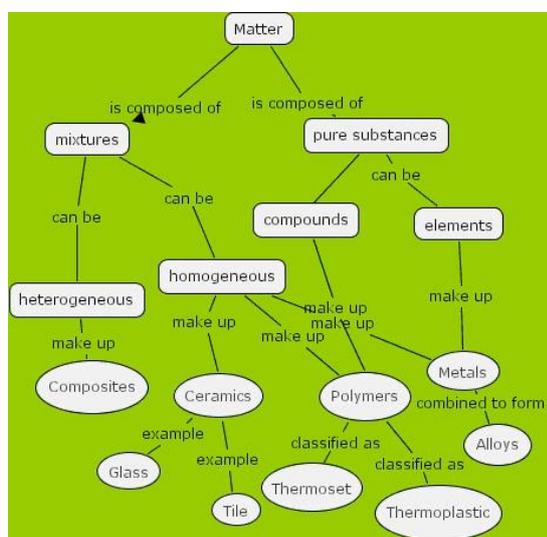
- Press reset. Place the indicated number of electrons in the atom and fill in the table after each addition.

Number of electrons	Mass number reading	Net charge reading
1		
2		
3		
4		

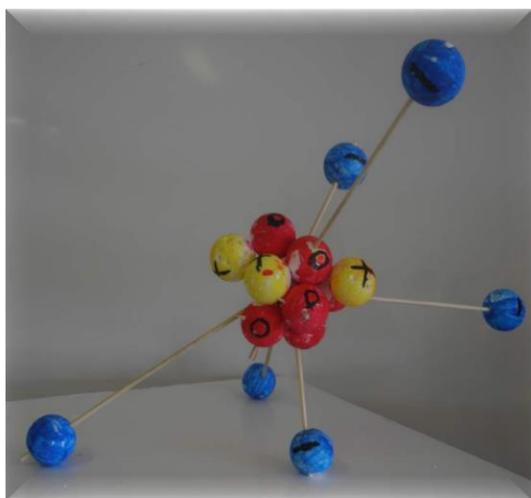
Look at your results and discuss in your group the answer to the following questions:

- What happens to the *mass* number reading when you add an electron? What do you think will happen to the mass number if you add another electron? Check using the simulation.
- What happens to the *charge* when you add an electron? What do you think will happen if you add another electron? Check your answer. Does an electron have a charge?

By working with the simulation, you should have found out about the mass, charge and location of the subatomic particles in an atom. Using the words **mass and charge** as well as the words in the envelope provided, develop a concept map on the large sheet provided showing what you have learned. Unsure what a concept map is? Two examples are shown below:



Extension activity: use your concept map to help you as you discuss the following question in your group.



A student was asked to develop a model of the atom and they presented the model shown in the picture. Discuss the following:

1. Does the model allow you identify which colour represents each of the three sub atomic particles? Be prepared to justify your answer.
2. Can you identify ways that the model could be improved to better represent the mass of the sub-atomic particles?

Student Resources

Cut up the following and place in envelope for each group

SHELLS	ELECTRONS
NUCLEUS	NEUTRONS
PROTONS	SUB-ATOMIC PARTICLES
ATOM	

Learning Outcomes in Focus

Contextual strands: BW2

Students should be able to describe asexual and sexual reproduction; *explore patterns in the inheritance and variation of genetically controlled characteristics.*

EXPLORE: Observe, study in order to establish facts.

Nature of science: NOS4

Students should be able to ...critically analyse data to identify patterns.

Learning Intentions

Through observing variation in inherited characteristics students will learn how phenotype and genotype relate

Prior Learning

Students have had some introduction to the language and the generalised ideas of inherited characteristics resulting from genes inherited from each of two parents. For the purpose of this activity it is presumed that:

- Each parent contributes one gene to the genotype (pair of genes) of offspring.
- That some genes are dominant over others
- That phenotype is the physical expression of a genotype, modelled here at its simplest - where there is a direct correlation between one genotype and one physically observable trait i.e. shape of eyes, face and mouth type.

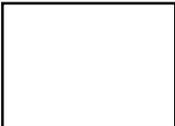
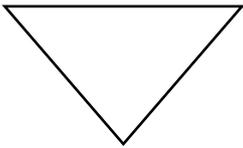
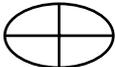
Student Activity Sheet: Build an offspring

By tossing a coin you will decide which of your two genes goes forward to each of 3 offspring. You will use the resulting **genotype** to predict the **phenotype** to build a picture of each of your offspring.

1. Decide who is parent 1 and who is parent 2.
2. In the table the genotype for each parent, one and two, for face shape, eye shape and mouth type is listed.

	Parent 1 genotype	Parent 2 genotype
Face shape	Ff	Ff
Eye shape	Ee	Ee
Mouth type	Mm	Mm

The phenotype corresponding to each gene is shown below

Face shape	F 	f 
Eye type	E 	e 
Mouth type	M 	m 

A CAPITAL letter (F, E, M.) represents a dominant gene.

3. Looking at your genotype, and using the phenotypes drawn above, discuss with your partner what each parent will look like. In the space below draw a picture of parent one.

Parent one

Discuss with your partner whether parent two will have the same mouth type.

4. Parent 1 flip the coin to decide which gene will go to your offspring to determine their face shape. If the coin lands on the side with a sticker it means your offspring gets a dominant gene from you. If it lands on the other side they get a recessive gene from you. Record the gene type in the appropriate space for offspring one.
5. Parent 2 now repeats the procedure by tossing the coin.
6. Record the genotype for that characteristic.
7. Repeat for each inherited characteristic and for each of 3 offspring.
8. Having selected the genotype for each offspring draw a picture of what each of your offspring will look like – i.e. show the phenotype for each combination of genes.

Offspring 1

	Gene from parent 1	Gene from parent 1	Genotype
Face shape			
Eye type			
Mouth type			

Offspring 2

	Gene from parent 1	Gene from parent 2	Genotype
Face shape			
Eye type			
Mouth type			

Offspring 3

	Gene from parent 1	Gene from parent 2	Genotype
Face shape			
Eye type			
Mouth type			

Draw a picture of each of the offspring here to show the phenotype.

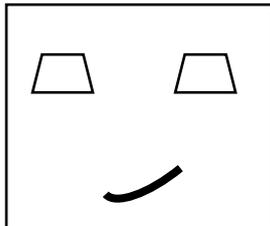
Offspring 1

Offspring 2

Offspring 3

Discuss the following ideas with your partner:

1. Does knowing the genotype allow you to predict the phenotype?
2. Does knowing the phenotype allow you to be certain about the genotype?
3. What possible genotypes could result in the phenotype shown below?



Fill in your answers:

All possible genotypes for face:

All possible genotypes for eyes:

All possible genotypes for mouth:

Extension Activity

Were all possible gene combinations produced by tossing the coin? Were there any combinations which did not arise? If so draw pictures of these possible offspring in the space below.

Learning Outcomes in Focus

Contextual strand: BW4

Students should be able to *describe* the structure, functions and interactions of the organs of the human digestive, circulatory and respiratory systems.

DESCRIBE: Develop a detailed picture or image of, for example, a structure or process; using words or diagrams where appropriate; produce a plan, simulation or model.

Nature of science: NOS1

Students should be able to *appreciate how scientists work* and how scientific ideas are modified over time.

Learning Intentions

Students will learn to

1. Describe the interaction of the respiratory, digestive and circulatory systems through the development of a scientific model.

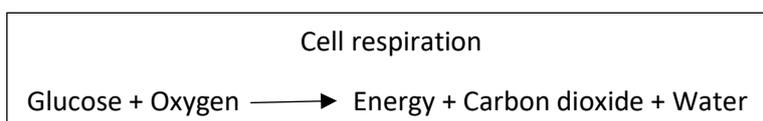
Prior Learning

Students can describe the structure and functioning of each of the three systems and can describe respiration as a chemical and biological process.

Student Activity Sheet

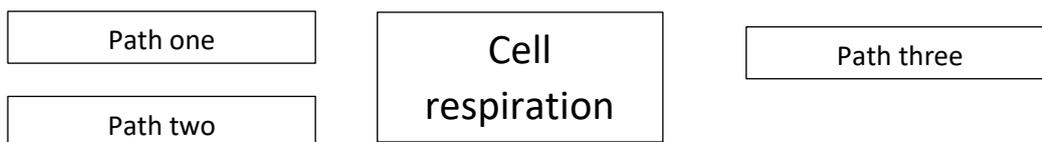
Scientists often develop models to explain how things work. A *scientific model* can be a diagram or a drawing or some other representation which helps to explain a process. On completing this activity, you will have developed a model to explain how some of your bodily systems work together.

1. Place the card representing cell respiration on the floor or a large table.



- Show the path of carbohydrates from the mouth to the cell using all the cards numbered 1. (Path one)
- Show the path of oxygen from the mouth/nose to the cell using all the cards numbered 2. (Path two)
- Show how Carbon dioxide and water are eliminated from the body using all the cards numbered 3. (Path three).

You will end up with a structure similar to that shown below.

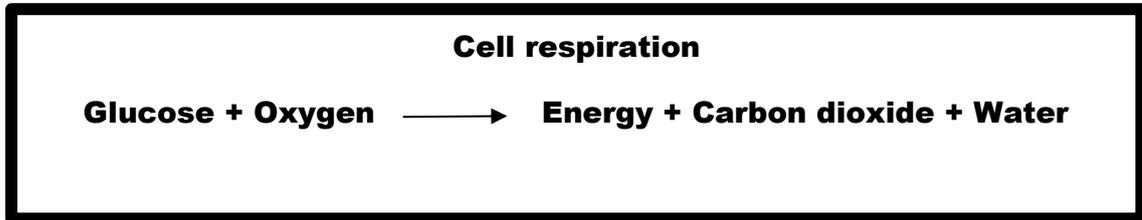


The structure represents how the digestive system, circulatory system and respiratory system work together to allow cell respiration to happen. However, this model shows more than one heart and more than one representation of the organs of the respiratory system. On the sheet provided develop a more appropriate model using words and/or diagrams which shows clearly how the three systems work together to facilitate cell respiration.

Extension activity

Can you indicate on your diagram/ model where other systems you know of might also contribute to this process? Some systems you might consider are the skeletal system, the nervous system and the muscular system.

Student Resources



Set 1: Cut up and put number 1 on all of the following:

STOMACH	HEART
MOUTH	BLOOD IN ARTERIES
SMALL INTESTINE	OESOPHAGUS
CAPILLARIES	CAPILLARIES
BLOOD IN VEINS	

Set 2: Cut out and put number 2 on all of the following:

HEART	BRONCHUS
CAPILLARIES	MOUTH/NOSE
BRONCHIOLES	BLOOD IN ARTERIES
TRACHEA	ALVEOLI
CAPILLARIES	BLOOD IN PULMONARY VEIN

SET 3: Cut out and put number 3 on all of the following:

BRONCHUS	BLOOD IN VEINS
HEART	BRONCHIOLES
TRACHEA	MOUTH/NOSE
BLOOD IN PULMONARY ARTERY	ALVEOLI
CAPILLARIES	CAPILLARIES

Learning Outcomes in Focus

Contextual strands: E&S 2

Students should be able to *explore* a scientific model to illustrate the origin of the universe

EXPLORE: Observe, study in order to establish facts.

Nature of science: NoS1

Students should be able to *appreciate how scientists work* and how scientific ideas are modified over time.

Learning Intentions

- Students will study a model of the expanding Universe to establish how evidence supports the theory that the Universe is expanding.
- Students will gain some practical understanding of how scientists develop scientific models to explain phenomena

Prior Learning

Students have researched the BIG Bang theory and learned that:

- The Big Bang created space and matter
- The universe is expanding
- Our early universe was simple, as it expanded atomic matter formed
- Gravity caused atoms to form galaxies and solar systems

Exploring the BIG Bang Theory (Teacher background)

The Big Bang theory suggests that our Universe is expanding. In this activity students will explore a model to see whether evidence exists to support this. For the theory to be supported students should find that

1. All objects in our Universe must be moving away from each other.
2. Objects that are further away from us are moving away from us more quickly than objects that are close to us.

Using data gathered from observing the movement of galaxies scientists can develop a two-dimensional model of an imaginary galaxy field, where galaxies are represented by dots as shown on Student Worksheet Galaxy Field A and B. In a real galaxy field image the galaxies do not have a regular shape and are not as evenly spread. The model works on the premise that the image presented as Student Worksheet Galaxy Field B was taken one second after Student Worksheet Galaxy Field A and so represents the passing of one second.

NOTE: Each group needs one copy of STUDENT WORKSHEET Galaxy Field A, STUDENT WORKSHEET Galaxy Field B and a copy of STUDEN WORKSHEET Galaxy Field B copied onto a transparency.

STUDENT ACTIVITY SHEET

Using data gathered from observing the movement of galaxies, scientists can develop a two-dimensional model of an image (or picture) of a section of the Universe. In this model galaxies are represented by different sized dots as shown on Student Worksheet Galaxy Field A and B. Image B is also on a transparency for use later. The model works by imagining that image B was taken **one second after** image A.

1. On Student Worksheet A, measure and record the distance between 4 pairs of galaxies to complete the table. Before you begin discuss where you will take your measurements from (e.g. the middle of the dot /near edge etc.). It doesn't matter where you choose so long as you always measure from the same place.

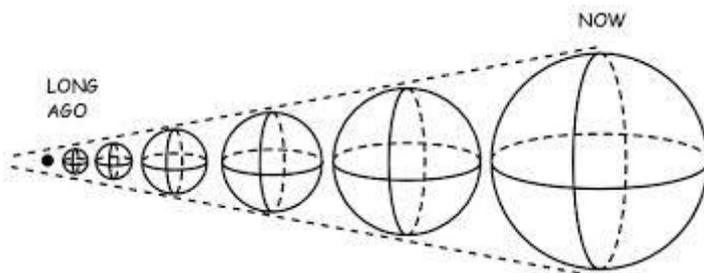
Named pair of Galaxies (e.g. A – C)	Distance between the galaxies

2. Now repeat FOR THE SAME PAIRS but using Student Worksheet B and record your results in the table below. Remember to measure from the point that you did in step 1 to allow for comparison.

Named pair of Galaxies (e.g. A – C)	Distance between the galaxies

3. If B represents an image of a galaxy field taken one second after the image A discuss in your groups what has happened to the distances between the galaxies in that second?
4. Imagine your group were to stand on one of the galaxies A, B,C,D,E, or F and you were looking out at all the other galaxies. Discuss in your groups whether you think the other galaxies would be moving towards you, away from you or staying in the same place.
5. Pick a galaxy to stand on. This galaxy will not appear to you to move. Lay the **transparency Galaxy Field B** on top of the sheet Galaxy Field A. Move the transparency so that the chosen galaxy on the transparency is **directly on top** of that same galaxy on the worksheet. Look at the other galaxies. In the passing of the second between image A and image B what has happened to the other galaxies? Discuss your observations in your group.
6. Now move to another galaxy and repeat the process, by moving the transparency make sure it is lined up correctly. Repeat for a third time, again moving the transparency. Discuss what you have observed in your groups and then attempt to answer the question overleaf.

The Big Bang theory suggests that the Universe is expanding since its origin.



- Does what you have observed from the model provide you with any evidence to support this theory? Support your answer by referring to what you saw on the model.

- For the final part of this activity imagine you are standing on galaxy B. Line up the transparency so that B on the transparency is on top of B on worksheet called Galaxy Field A. In the second between image A (on sheet) and image B (on transparency) measure how far each of these galaxies moved.

Galaxy	Distance in cm
A	
C	
D	
E	
F	

Use these results to help you with the next question.

The Big Bang Theory suggests that if the Universe is expanding then objects that are further away move away more quickly than objects which are close to us. Explain, with justification, how your observations support/do not support this aspect of the Big Bang theory.

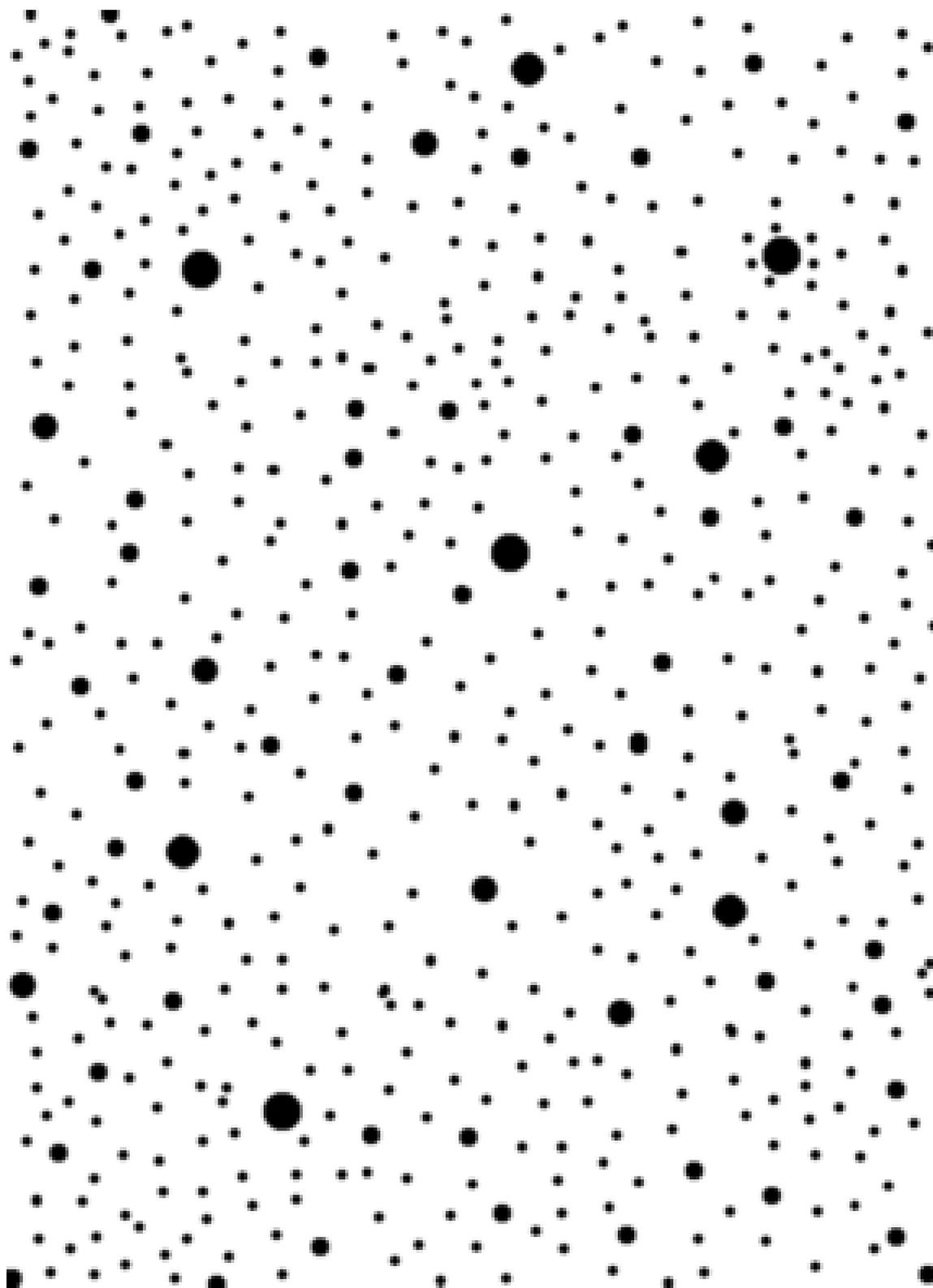
Extension Activity

The model was developed based on data recorded by scientists measuring the movement of galaxies.

State two things that it suggests about the movement of galaxies.

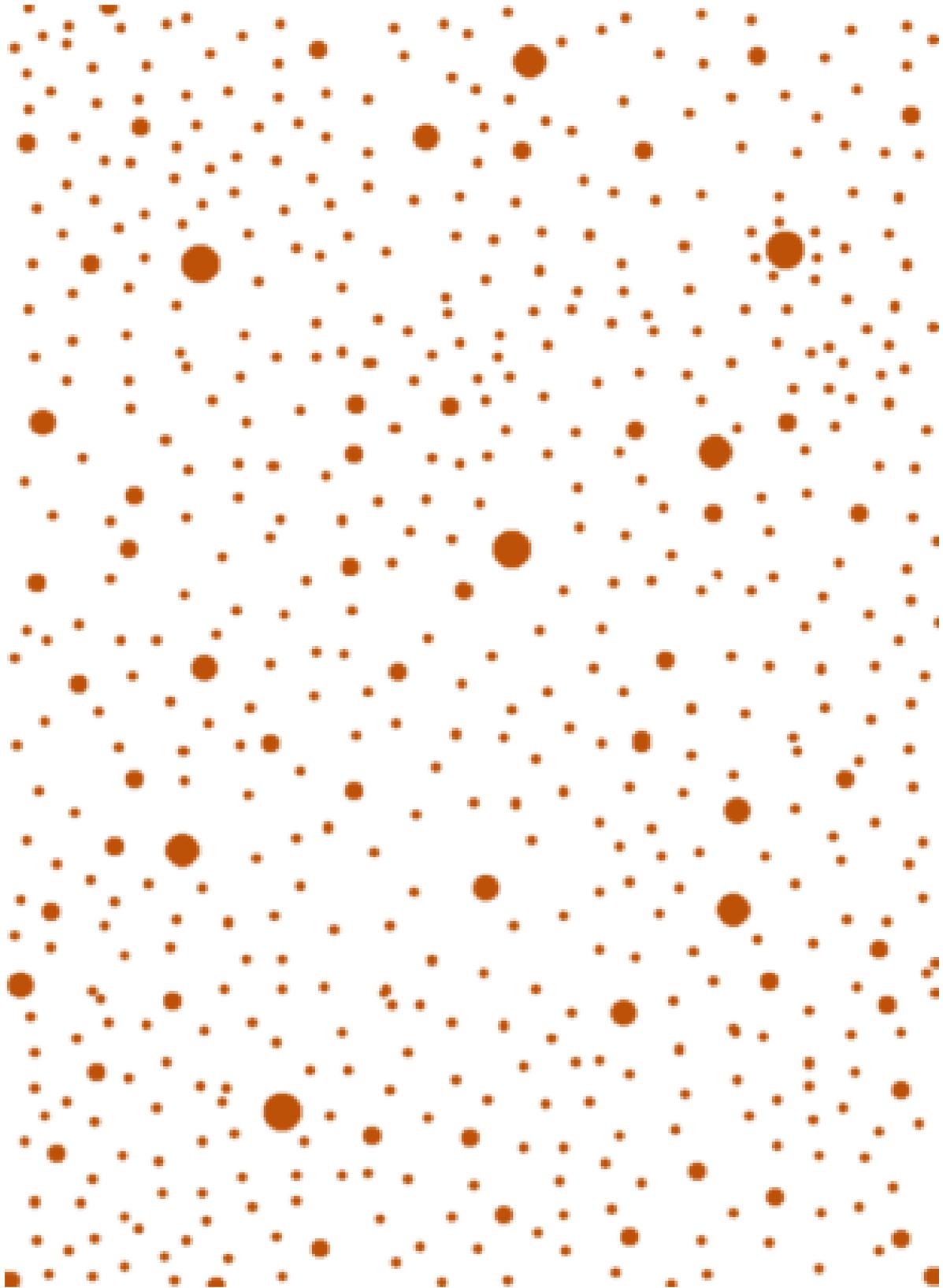
Are there any ways that the model is limited in how it supports the big Bang Theory?

GALAXY FIELD A

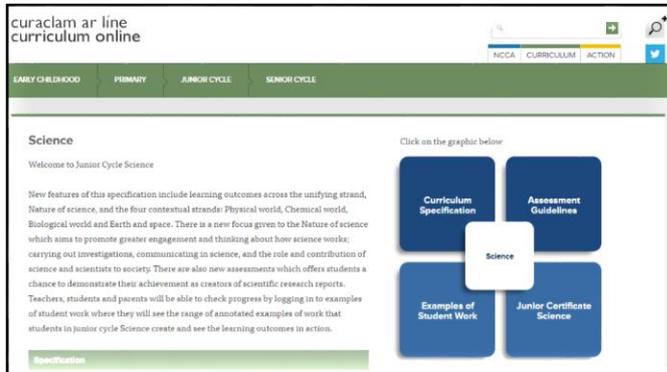


Adapted from "Modelling the Expanding Universe"- Astronomical Society of the Pacific

GALAXY FIELD B



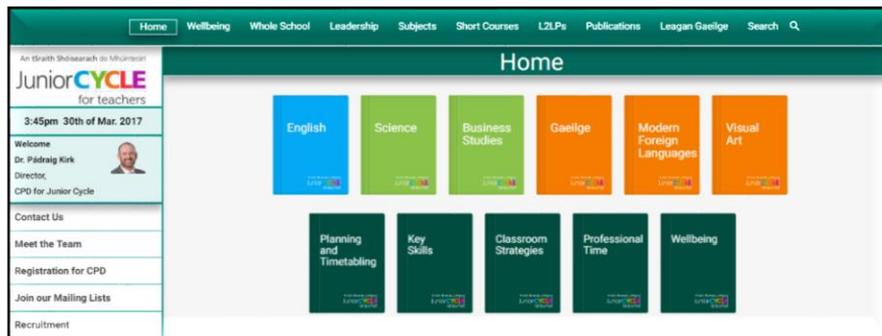
Adapted from “Modelling the Expanding Universe” – Astronomical Society of the Pacific



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- Information for teachers
- Videos for students
- Information leaflets for parents



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- Webinars
- News and events
- Learning outcomes in focus

Thank you for participating in this workshop. We hope you enjoyed it!

Why not visit our stand where you can

- Have your Junior Cycle Science questions answered
- Collect resources which will assist you in planning for Junior Cycle Science
- Get advice from the full-time science team
- Find out more about what supports we can offer you – both online and onsite.

Contact details

For any queries, please contact us on one of the following:



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