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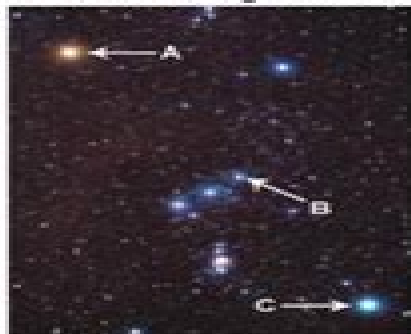
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## Student Exploration: H-R Diagram

**Directions:** Follow the instructions to go through the simulation. Respond to the questions and prompts in the orange boxes.

**Vocabulary:** giant, H-R diagram, luminosity, main sequence, star, supergiant, white dwarf

**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)



1. The image at left shows three **stars** in the constellation Orion: Betelgeuse (A), Rigel (B), and Saiph (C). How do the appearances of **stars** A, B, and C compare?

The colors are different and so are the sizes. Betelgeuse is yellow, Rigel is blue, and Saiph is light blue (and the smallest).

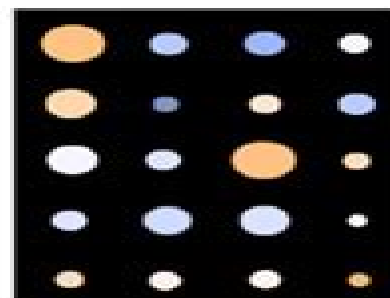
2. What are some ways the stars in the photo could be grouped or classified?

They can be separated and classified for their temperatures and brightness.

### Gizmo Warm-up

In the early 1900s, astronomers identified many star characteristics such as color, size, temperature, and **luminosity**—or how bright a star is. Using the *H-R Diagram Gizmo*, you will discover how some of these characteristics are related.

Start by moving your cursor over the stars in the **Star collection**. Star information is displayed on the right side of the Gizmo. The numbers given for **Luminosity**, **Radius**, and **Mass** are in comparison to the Sun. So, a star with a radius of "2 Suns" is twice as large as the Sun. **Temperature** is given using the Kelvin scale, where 273.15 K = 0 °C and 373.15 K = 100 °C.



1. Find Betelgeuse in the **Star collection**. Click the chart, click **Edit** . Fill out the chart at right.
2. The Sun has a radius of 695,500 km.

What is the radius of Betelgeuse?

Betelgeuse	
Temperature	3400K
Luminosity	9500
Radius	1000
Mass	20

# Student Exploration Natural Selection

**Alberto Bellocchi, Cassie  
Quigley, Kathrin Otrell-Cass**



## **Student Exploration Natural Selection:**

*Ecology, a Systems Approach* Prassede Calabi, 1998      Evolution Challenges Karl S. Rosengren, Sarah K. Brem, E. Margaret Evans, Gale M. Sinatra, 2012-04-23 A recent poll revealed that one in four Americans believe in both creationism and evolution while another 41% believe that creationism is true and evolution is false A minority only 13% believe only in evolution Given the widespread resistance to the idea that humans and other animals have evolved and given the attention to the ongoing debate of what should be taught in public schools issues related to the teaching and learning of evolution are quite timely Evolution Challenges Integrating Research and Practice in Teaching and Learning about Evolution goes beyond the science versus religion dispute to ask why evolution is so often rejected as a legitimate scientific fact focusing on a wide range of cognitive socio cultural and motivational factors that make concepts such as evolution difficult to grasp The volume brings together researchers with diverse backgrounds in cognitive development and education to examine children s and adults thinking learning and motivation and how aspects of representational and symbolic knowledge influence learning about evolution The book is organized around three main challenges inherent in teaching and learning evolutionary concepts folk theories and conceptual biases motivational and epistemological biases and educational aspects in both formal and informal settings Commentaries across the three main themes tie the book together thematically and contributors provide ideas for future research and methods for improving the manner in which evolutionary concepts are conveyed in the classroom and in informal learning experiences Evolution Challenges is a unique text that extends far beyond the traditional evolution debate and is an invaluable resource to researchers in cognitive development science education and the philosophy of science science teachers and exhibit and curriculum developers      **Teaching About Evolution and the Nature of Science** National Academy of Sciences, Division of Behavioral and Social Sciences and Education, Board on Science Education, Working Group on Teaching Evolution, 1998-04-06 Today many school students are shielded from one of the most important concepts in modern science evolution In engaging and conversational style Teaching About Evolution and the Nature of Science provides a well structured framework for understanding and teaching evolution Written for teachers parents and community officials as well as scientists and educators this book describes how evolution reveals both the great diversity and similarity among the Earth s organisms it explores how scientists approach the question of evolution and it illustrates the nature of science as a way of knowing about the natural world In addition the book provides answers to frequently asked questions to help readers understand many of the issues and misconceptions about evolution The book includes sample activities for teaching about evolution and the nature of science For example the book includes activities that investigate fossil footprints and population growth that teachers of science can use to introduce principles of evolution Background information materials and step by step presentations are provided for each activity In addition this volume Presents the evidence for evolution including how evolution can be observed today Explains the nature of science through a

variety of examples Describes how science differs from other human endeavors and why evolution is one of the best avenues for helping students understand this distinction Answers frequently asked questions about evolution Teaching About Evolution and the Nature of Science builds on the 1996 National Science Education Standards released by the National Research Council and offers detailed guidance on how to evaluate and choose instructional materials that support the standards Comprehensive and practical this book brings one of today s educational challenges into focus in a balanced and reasoned discussion It will be of special interest to teachers of science school administrators and interested members of the community

**Tactical Teacher** Dale Ripley,2021-12-31 Positively influence the behavior of even your most challenging students In The Tactical Teacher author Dale Ripley shares a plethora of tactics ranging from persuasive dialogue to environmental details proven to improve students classroom behavior and increase learning You ll gain powerful research based strategies for addressing disruptions developing productive student teaching relationships and motivating students to embrace learning like never before Readers will Consider how the experiences of ancient humans still impact student behavior Understand the benefits of soft tactics the risks of hard tactics and how to make effective use of both Forge positive relationships with even your most challenging or disruptive students Explore the ethics of using specific influence and persuasion strategies in the classroom Help students engage in learning through the tactics portrayed in each chapter

Contents Introduction Chapter 1 Why Your Students Behave the Way They Do Chapter 2 Student Behavior Through the Lens of Natural Selection Chapter 3 Soft Tactics for Helping Your Students Create a Positive Self Image Chapter 4 Soft Tactics for Reciprocation Chapter 5 Soft Tactics for Likeability Chapter 6 Soft Tactics for the Power of Commitment Chapter 7 Soft Tactics for Making the Invisible Visible Chapter 8 Soft Tactics for Empathetic Persuasion of Students Thinking Chapter 9 Soft Tactics for Your Classroom s Physical Environment Chapter 10 Soft Tactics for Motivating Students by Taking Something Away Chapter 11 Soft Tactics for Persuading Students With the Right Words Chapter 12 Soft Tactics for Motivating Students Through Rewards Chapter 13 Soft Tactics for Making a Great First Impression Chapter 14 Hard Tactics to Use With Extreme Caution Chapter 15 Soft Tactics for Knowing When to Influence Your Students Chapter 16 The Ethics of Influence Chapter 17 How Your Students Subconsciously Motivate You Epilogue Appendix References and Resources Index ENC Focus ,2001

*Classroom Instruction That Works* Ceri B. Dean,Elizabeth Ross Hubbell,2012-01-15 This book draws on research and developments in the twenty first century to reanalyze and reevaluate the teaching strategies that have the most positive effect on student learning

**Ready, Set, SCIENCE!** National Research Council,Division of Behavioral and Social Sciences and Education,Center for Education,Board on Science Education,Heidi A. Schweingruber,Andrew W. Shouse,Sarah Michaels,2007-10-30 What types of instructional experiences help K 8 students learn science with understanding What do science educators teachers teacher leaders science specialists professional development staff curriculum designers and school administrators need to know to create and support such experiences Ready Set Science guides the way with an

account of the groundbreaking and comprehensive synthesis of research into teaching and learning science in kindergarten through eighth grade Based on the recently released National Research Council report Taking Science to School Learning and Teaching Science in Grades K 8 this book summarizes a rich body of findings from the learning sciences and builds detailed cases of science educators at work to make the implications of research clear accessible and stimulating for a broad range of science educators Ready Set Science is filled with classroom case studies that bring to life the research findings and help readers to replicate success Most of these stories are based on real classroom experiences that illustrate the complexities that teachers grapple with every day They show how teachers work to select and design rigorous and engaging instructional tasks manage classrooms orchestrate productive discussions with culturally and linguistically diverse groups of students and help students make their thinking visible using a variety of representational tools This book will be an essential resource for science education practitioners and contains information that will be extremely useful to everyone including parents directly or indirectly involved in the teaching of science

Science Instruction in the Middle and Secondary Schools

Eugene L. Chiappetta, Thomas R. Koballa (Jr.), Alfred T. Collette, 1998 New edition of a text providing far more than simply a cookbook of activities for science teachers Coverage includes discussion on the nature of science national standards and innovative programs the nature of adolescent learners and their schools teaching strategies and classroom management pl

*EVO Teachers Guide* Rodger W. Bybee, John Feldman, 2012 In this film you ll learn among other things that evolution and religion are indeed compatible ways of looking at the world that Darwin was a creationist before he was an evolutionist and that cooperation is just as important as competition in the struggle for existence From Hummingbird Films website

Teaching Inquiry Science in Middle and Secondary Schools Anton E. Lawson, 2010 This textbook provides an introduction to inquiry oriented secondary science teaching methods

**Confronting Prior Conceptions in Paleontology Courses**

Margaret M. Yacobucci, 2018-11-15 People hold a variety of prior conceptions that impact their learning Prior conceptions that include erroneous or incomplete understandings represent a significant barrier to durable learning as they are often difficult to change While researchers have documented students prior conceptions in many areas of geoscience little is known about prior conceptions involving paleontology In this Element data on student prior conceptions from two introductory undergraduate paleontology courses are presented In addition to more general misunderstandings about the nature of science many students hold incorrect ideas about methods of historical geology Earth history ancient life and evolution Of special note are student perceptions of the limits of paleontology as scientific inquiry By intentionally eliciting students prior conceptions and implementing the pedagogical strategies described in other Elements in this series lecturers can shape instruction to challenge this negative view of paleontology and improve student learning

**Crossing the**

**threshold** Andreas C. Göransson, 2021-02-18 The theory of evolution is considered the unifying theory of biology An accurate understanding of evolution is vital both for the understanding of diverse topics in biology but also for societal issues such as

antibiotic resistance or biodiversity In contrast decades of research in science education have revealed that students have difficulties to accurately understand evolutionary processes such as mutation and natural selection The majority of this research relies on a conceptual framework of so called key concepts variation selection inheritance derived from scholarly descriptions of natural selection Recent research suggests that non domain specific concepts such as randomness probability spatial and temporal scales so called threshold concepts are important for evolution understanding in addition to the key concepts Thus many important elements of evolutionary theory are counter intuitive or lie outside direct perception Hence representations such as visualizations models and simulations are considered to be important for teaching and learning evolution While the importance of visualizations is generally acknowledged for science education less is known about how visual design can facilitate students understanding of threshold concepts such as random mutations or spatial scales This thesis uses the Model of Educational Reconstruction MER as the guiding framework for exploring the significance of threshold concepts by analysing the conceptual content of students explanations and extant visualizations of natural selection MER combines scientific content with teaching and learning perspectives for the analysis and design of learning environments Content analysis of visualizations available online showed that most fail to fully represent the basic principles of natural selection variation selection and inheritance Moreover the representational potential of visualizations was seldom used to represent threshold concepts such as randomness in origin of variation Visualizations were also biased to animals as the context of evolution Similarly upper secondary and tertiary students explanations of natural selection were seldom complete in terms of the basic principles and threshold concepts such as randomness were often lacking Especially significant was the almost complete lack of randomness in upper secondary students explanations In addition threshold concepts were context sensitive across the items used bacteria cheetah and salamander for example spatial scale and randomness was significantly more common in responses to the bacteria item compared to the cheetah and salamander items Considering the results from these studies three interactive visualizations were developed evolution of antibiotic resistance and fur colouration in mice The visualization design was conducted iteratively following a Design Based Research approach and evaluated in classroom settings in secondary and upper secondary Swedish schools The results showed that visualizations targeting randomness and genetic level events such as mutations can guide students towards a more scientific conception of natural selection However there were differences across the visualizations and student samples In addition while students often inferred randomness from the visuals the results showed that integration of randomness into explanations of natural selection may be challenging Hence future research should explore the role of guidance and reflection for students understanding of randomness The thesis also discusses the role of students intuitive conceptions in relation to the use of interactive visualizations and how these preconceptions interact with the presented message By using the theory of frame semantics framing effects and conceptual integration students issues of achieving an accurate

understanding of evolution are discussed in relation to the theory of conceptual change Implications for teaching and learning natural selection as well as visualization design for learning are also discussed Evolutionsteorin f rs ofta fram som biologins f renande teori Vikten av en korrekt och anv ndbar evolutionsf rst else har d rf r ofta betonats inte minst f r elevers f rst else inom biologins olika delomr den men ocks f r att fatta beslut i samh llsfr gor som exempelvis antibiotikaresistens M nga av de centrala delarna av evolutionsteorin r kontraintuitiva eller abstrakta och decennier av forskning har visat att elever har sv righeter att f rst evolution ra processer som mutation och naturligt urval Representationer s som visualiseringar modeller och simuleringar r d rf r viktiga f r att ge elever direkta erfarenheter av evolution ra processer ven om vikten av visualiseringar r allm nt accepterad inom naturvetenskapsundervisning s r det mindre k nt hur visualiseringars utformning specifikt bidrar till att utveckla elevers f rst else av vetenskapliga fenomen s som evolution Dessutom har forskningen p elevers evolutionsf rst else till stor del fokuserat p s kallade nyckelbegrepp variation selektion och arv som h rletts fr n vetenskapliga beskrivningar av evolutionsteorin Dessa begrepp antas vara n dv ndiga men ocks tillr ckliga f r elevers evolutionsf rst else Dock har vikten av icke dom nspecifika begrepp kopplade till evolutionsteorin s som slump sannolikhet spatial och temporala skalor s kallade tr skelbegrepp inte unders kts i n gon h gre grad Den h r avhandlingen anv nder Model of Educational Reconstruction f r att utforska betydelsen av tr skelbegrepp f r evolutionsf rst else Med utg ngspunkt i den vetenskapliga beskrivningen och historiken unders ks f rekomsten av tr skelbegrepp i befintliga visualiseringar f r l rande samt elevers f rklaringar f r att formulera designprinciper f r interaktiva visualiseringar av evolution Dessutom beskrivs utvecklingen av ett antal interaktiva visualiseringar samt unders kningar av deras potentiella anv ndning i klassrumsmilj er Avhandlingen diskuterar ven betydelsen av elevers intuitiva f rest llningar i relation till anv ndandet av interaktiva visualiseringar och hur dessa f rest llningar interagerar med det presenterade budskapet Genom anv ndning av ramsemantisk teori inklusive framingeffekter och blendteori diskuteras elevers sv righeter och utveckling av en vetenskaplig evolutionsf rst else i relation till tidigare teorier om begrepps f r ndring Konsekvenser av ramsemantisk teori och framingeffekter i visuella medier diskuteras ven i relation till visuell design f r l rande

**Exploring Mathematics and Science Teachers' Knowledge** Hamsa Venkat, Marissa Rollnick, John Loughran, Mike Askew, 2014-05-09 Globally mathematics and science education faces three crucial challenges an increasing need for mathematics and science graduates a declining enrolment of school graduates into university studies in these disciplines and the varying quality of school teaching in these areas Alongside these challenges internationally more and more non specialists are teaching mathematics and science at both primary and secondary levels and research evidence has revealed how gaps and limitations in teachers content understandings can lead to classroom practices that present barriers to students learning This book addresses these issues by investigating how teachers content knowledge interacts with their pedagogies across diverse contexts and perspectives This knowledge practice nexus is examined across mathematics and science teaching traversing schooling

phases and countries with an emphasis on contexts of disadvantage These features push the boundaries of research into teachers content knowledge The book s combination of mathematics and science enriches each discipline for the reader and contributes to our understandings of student attainment by examining the nature of specialised content knowledge needed for competent teaching within and across the two domains Exploring Mathematics and Science Teachers Knowledge will be key reading for researchers doctoral students and postgraduates with a focus on Mathematics Science and teacher knowledge research

*Bulletin of the Atomic Scientists* ,1968-10 The Bulletin of the Atomic Scientists is the premier public resource on scientific and technological developments that impact global security Founded by Manhattan Project Scientists the Bulletin s iconic Doomsday Clock stimulates solutions for a safer world

Evolution in Hawaii National Academy of Sciences,Steve Olson,2004-03-10 As both individuals and societies we are making decisions today that will have profound consequences for future generations From preserving Earth s plants and animals to altering our use of fossil fuels none of these decisions can be made wisely without a thorough understanding of life s history on our planet through biological evolution Companion to the best selling title Teaching About Evolution and the Nature of Science Evolution in Hawaii examines evolution and the nature of science by looking at a specific part of the world Tracing the evolutionary pathways in Hawaii we are able to draw powerful conclusions about evolution s occurrence mechanisms and courses This practical book has been specifically designed to give teachers and their students an opportunity to gain a deeper understanding of evolution using exercises with real genetic data to explore and investigate speciation and the probable order in which speciation occurred based on the ages of the Hawaiian Islands By focusing on one set of islands this book illuminates the general principles of evolutionary biology and demonstrate how ongoing research will continue to expand our knowledge of the natural world

*The Cambridge Handbook of the Learning Sciences* R. Keith Sawyer,2022-04-07 The interdisciplinary field of the learning sciences encompasses educational psychology cognitive science computer science and anthropology among other disciplines The Cambridge Handbook of the Learning Sciences first published in 2006 is the definitive introduction to this innovative approach to teaching learning and educational technology In this significantly revised third edition leading scholars incorporate the latest research to provide seminal overviews of the field This research is essential in developing effective innovations that enhance student learning including how to write textbooks design educational software prepare effective teachers and organize classrooms The chapters illustrate the importance of creating productive learning environments both inside and outside school including after school clubs libraries and museums The Handbook has proven to be an essential resource for graduate students researchers consultants software designers and policy makers on a global scale

Newly Hired Teachers of Science Julie A. Luft,Shannon L. Dubois,2015-12-09 Supporting newly hired science teachers has taken on an increased importance in our schools This book shares the most current information about the status of newly hired science teachers different ways in which to support newly hired science teachers and different research



approaches that can provide new information about this group of teachers Chapters in the book are written by those who study the status of beginning science teachers mentor new teachers develop induction programs and research the development of new science teachers Newly Hired Teachers of Science is for administrators who have new science teachers in their schools and districts professionals who create science teacher induction programs mentors who work closely with new science teachers educational researchers interested in studying new science teachers and even new science teachers This is a comprehensive discussion about new science teachers that will be a guiding document for years to come

**A Student's Guide to Education Studies** Stephen Ward, 2013-01-04 A Student's Guide to Education Studies is a much needed resource for any undergraduate making their first explorations into the fascinating world of education The first publication of this book in 2002 helped to define the nature of the subject introducing topics into the field which had not been previously considered This new edition brings the subject up to date with the latest thinking and research on policy globalisation learning and knowledge offering an accessible and wide ranging introduction to a diverse range of topics and issues in education Now fully updated to reflect rapid and significant changes in the field this third edition considers topical issues including the political dimension of education the national debate about schooling and poverty the marketisation of education the end of Every Child Matters the Coalition Government's policies for academies and free schools Organised around three enduring themes Education Policy and Politics Global and Environmental Education and Learning Knowledge and the Curriculum each chapter contains summary points questions for discussion and annotated suggestions for further reading With a distinctive international and global focus A Student's Guide to Education Studies is an essential resource for all students of Education Studies

*Entrepreneurship - Digital Transformation, Education, Opportunities and Challenges*, 2025-01-29 Digital transformation and artificial intelligence play an important role in entrepreneurship This book adopts a multidisciplinary approach to entrepreneurship exploring how entrepreneurial processes contribute to developing new products and services and innovative business models Recent shifts in business models focus on digital transformation and well being Entrepreneurship is evolving with innovative approaches and artificial intelligence is revolutionizing marketing strategies and market engagement This volume presents a comprehensive overview of entrepreneurship digital transformation and entrepreneurial education It is designed for entrepreneurs researchers teachers students and anyone interested in understanding and leveraging these trends

**Exploring Emotions, Aesthetics and Wellbeing in Science Education Research** Alberto Bellocchi, Cassie Quigley, Kathrin Otrrel-Cass, 2016-10-19 This book addresses new research directions focusing on the emotional and aesthetic nature of teaching and learning science informing more general insights about wellbeing It considers methodological traditions including those informed by philosophy sociology psychology and education and how they contribute to our understanding of science education In this collection the authors provide accounts of the underlying ontological epistemological methodological perspectives and theoretical assumptions that inform their work

and that of others Each chapter provides a perspective on the study of emotion aesthetics or wellbeing using empirical examples or a discussion of existing literature to unpack the theoretical and philosophical traditions inherent in those works This volume offers a diverse range of approaches for anyone interested in researching emotions aesthetics or wellbeing It is ideal for research students who are confronted with a cosmos of research perspectives but also for established researchers in various disciplines with an interest in researching emotions affect aesthetics or wellbeing

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