

Cooperative Learning &
Science
High School Activities



Michael Michels
Angela Manzi
Janina Mele

Australian Edition by Alison Stone, Hawker Brownlow Education

HAWKER BROWNLOW
•
E D U C A T I O N

Table of Contents

Table of Contents

CHART OF STRUCTURES	V
BIOLOGY OVERVIEW	VI
CHEMISTRY OVERVIEW	VIII
EARTH SCIENCE OVERVIEW	X
PHYSICAL SCIENCE OVERVIEW	XII
GENERAL SCIENCE & LABORATORY OVERVIEW	XIV
FOREWORD	XVII
INTRODUCTION	XXV
SCIENCE STRUCTURES	I

STRUCTURES FOR SCIENCE

1. FIND SOMEONE WHO

Biology

- Activity Ideas6
- Blackline Masters8

Chemistry

- Activity Ideas10
- Blackline Masters12

Earth Science

- Activity Ideas14
- Blackline Masters16

Physical Science

- Activity Ideas18
- Blackline Masters20

General Science & Laboratory

- Blackline Masters22

2. PAIRS CHECK

Biology

- Activity Ideas30
- Blackline Masters32

Chemistry

- Activity Ideas34
- Blackline Masters36

Earth Science

- Activity Ideas38
- Blackline Masters40

Physical Science

- Activity Ideas42
- Blackline Masters44

General Science & Laboratory

- Activity Ideas46
- Blackline Masters48

3. CORNERS

Biology

- Activity Ideas52
- Blackline Masters54

Chemistry

- Activity Ideas64
- Blackline Masters66

Earth Science

- Activity Ideas75

- Blackline Masters77

Physical Science

- Activity Ideas86
- Blackline Masters88

General Science & Laboratory

- Activity Ideas96

Table of Contents Cont.

Table of Contents

4. MIX-N-MATCH

Biology

- Activity Ideas100
- Blackline Masters104

Chemistry

- Activity Ideas114
- Blackline Masters116

Earth Science

- Activity Ideas126
- Blackline Masters128

Physical Science

- Activity Ideas138
- Blackline Masters140

General Science & Laboratory

- Activity Ideas150
- Blackline Masters152

5. WORD WEBBING

Biology

- Activity Ideas156
- Blackline Masters158

Chemistry

- Activity Ideas162
- Blackline Masters164

Earth Science

- Activity Ideas168
- Blackline Masters170

Physical science

- Activity Ideas172
- Blackline Masters174

General Science & Laboratory

- Activity Ideas178
- Blackline Masters179

6. GIVE ONE, GET ONE

Biology

- Activity Ideas186
- Blackline Masters188

Chemistry

- Activity Ideas190
- Blackline Masters192

Earth Science

- Activity Ideas194

- Blackline Masters196

Physical Science

- Activity Ideas198
- Blackline Masters200

General Science & Laboratory

- Blackline Masters202

7. MORE SCIENCE STRUCTURES

- Agree-Disagree Line-Ups**206
- Activity Ideas207
- Blackline Masters209

- Fan-N-Pick**213
- Blackline Masters214

- Mix-Freeze-Group**222
- Blackline Masters223

- Numbered Heads Together**227
- Blackline Masters228

- Sequencing**230
- Activity Ideas231
- Blackline Masters232

- Showdown**243
- Blackline Masters244

- Telephone**252
- Activity Ideas253

- Timed Pair Share**255
- Blackline Masters256

Chart of Structures



Structures	Activity Ideas		Blacklines		Activity Ideas		Blacklines		Activity Ideas		Blacklines		Activity Ideas		Blacklines																																													
	6	8	10	12	14	16	18	20	N/A	22	30	32	34	36	38	40	42	44	46	48	52	54	64	66	75	77	86	88	96	N/A	100	104	114	116	126	128	138	140	150	152	156	158	162	164	168	170	172	174	178	179	186	188	190	192	194	196	198	200	N/A	202
Find Someone Who	6	8	10	12	14	16	18	20	N/A	22	30	32	34	36	38	40	42	44	46	48	52	54	64	66	75	77	86	88	96	N/A	100	104	114	116	126	128	138	140	150	152	156	158	162	164	168	170	172	174	178	179	186	188	190	192	194	196	198	200	N/A	202
Pairs Check	30	32	34	36	38	40	42	44	46	48	52	54	64	66	75	77	86	88	96	N/A	100	104	114	116	126	128	138	140	150	152	156	158	162	164	168	170	172	174	178	179	186	188	190	192	194	196	198	200	N/A	202										
Corners	52	54	64	66	75	77	86	88	96	N/A	100	104	114	116	126	128	138	140	150	152	156	158	162	164	168	170	172	174	178	179	186	188	190	192	194	196	198	200	N/A	202																				
Mix-N-Match	100	104	114	116	126	128	138	140	150	152	156	158	162	164	168	170	172	174	178	179	186	188	190	192	194	196	198	200	N/A	202																														
Word Webbing	156	158	162	164	168	170	172	174	178	179	186	188	190	192	194	196	198	200	N/A	202																																								
Give One, Get One	186	188	190	192	194	196	198	200	N/A	202																																																		

Biology

A c t i v i t i e s



Find Someone Who

Activity Ideas

1. Body Systems6
2. Organs6
3. Mitosis7
4. Photosynthesis7

Blacklines

1. DNA Hunt8
2. Biomes of the World9



Pairs Check

Activity Ideas

1. Transcription & Translation30
2. Reactions of Photosynthesis30
3. Terms of Cell Structure31
4. Population Genetics (Hardy Weinberg Equations) . .31

Blacklines

1. Genetics32
2. Innate or Learned?33



Corners

Activity Ideas

1. Macromolecules52
2. Kingdoms of Life52
3. Environmental Cycles53
4. Mutation Types53

Blacklines

1. Macromolecules54
2. Levels of Organisation59



Mix-N-Match

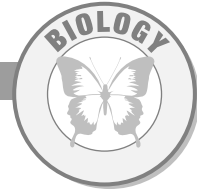
Activity Ideas

1. Phases of the Cell Cycle100
2. Identification of Organ Function100
3. Identification of Flower Parts101
4. Parts of a Microscope101
5. Macromolecules/Food102
6. Classification102
7. Other Activities103

Blackline

1. Digestion104

& B l a c k l i n e s



Word Webbing

Activity Ideas

1. Elements Essential for Life156
2. The Cell Theory156
3. Classification of Plants157
4. Human Evolution157

Blacklines

1. Energy Flow in an Ecosystem158
2. DNA160



Give One, Get One

Activity Ideas

1. Bones186
2. Plants186
3. Tidal Zone Species187
4. Genome Research187

Blacklines

1. Mammals188
2. Cellular Organelles189



More Structures

Agree-Disagree Line-Ups

- Activity Ideas** Bioethics207
- Blackline** Genetic Engineering209

Fan-N-Pick

- Blackline** Origins of Life214

Numbered Heads Together

- Blackline** Life228

Sequencing

- Activity Ideas**231
- Blackline** Cell Life Cycle232

Showdown

- Blackline** Cellular Organisation244

Telephone

- Activity Ideas** Cell Processes253

Timed Pair Share

- Blackline** Life and Change256

Chemistry

A c t i v i t i e s



Find Someone Who

Activity Ideas

1. Symbols Recognition10
2. Formula Recognition10
3. Periodic Table Recognition10
4. Chemical Properties Recognition11
5. Chemical Reactions Recognition11

Blacklines

1. Chemical Hunt12
2. Who Knows Their Acids and Bases13



Pairs Check

Activity Ideas

1. Balancing Equations34
2. Significant Digits/Maths Operations34
3. Naming Organic Molecules35
4. Drawing Structural Formulas35

Blacklines

1. Stoichiometry36
2. Formulas37



Corners

Activity Ideas

1. Types of Bonds64
2. States of Matter64
3. Changes of State65
4. Alkanes, Alkenes, Alkynes65
5. Solubility and Solutions65

Blacklines

1. Chemical Elements66
2. Solubility and Solutions71



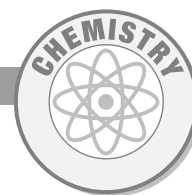
Mix-N-Match

Activity Ideas

1. Identification of Polyatomic Ions114
2. Atomic Structure114
3. Identification of Compounds115
4. Reaction Types115
5. Elements115

Blackline

1. Elements116



& B l a c k l i n e s



Word Webbing

Activity Ideas

1. Phases of Matter162
2. Solutions162
3. pH163
4. Gas Laws163

Blacklines

1. Chemistry Environmental Issues164
2. Periodic Table166



Give One, Get One

Activity Ideas

1. Ionic Compounds190
2. Metals190
3. Transitional Elements191
4. Water Pollution191

Blacklines

1. Lewis Dot Structures192
2. Properties: Chemical or Physical?193



More Structures

Agree-Disagree Line-Ups

- Activity Ideas** Chemical Technology207
Blackline Nuclear Energy210

Fan-N-Pick

- Blackline** Periodic Table216

Mix-Freeze-Group

- Blackline** Bond Sites223

Numbered Heads Together

- Blackline** Ions229

Sequencing

- Activity Ideas**231
Blackline Fractions of Distillation235

Showdown

- Blackline** History of the Periodic Table246

Telephone

- Activity Ideas** Families of the Periodic Table253

Timed Pair Share

- Blackline** Discussing Bonds257

Earth Science

A c t i v i t i e s



Find Someone Who

Activity Ideas

1. Natural Disasters Recognition14
2. Mineral Recognition14
3. Weather Terms Recognition15
4. Topographic Terms Recognition15

Blacklines

1. Wild Weather Worksheet16
2. A Cross-Section of the Earth17



Pairs Check

Activity Ideas

1. Astronomical Unit Conversions38
2. Half-Life Radioactive Problems38
3. Phases of the Moon39
4. Scientific Notation and Maths Operations39

Blacklines

1. Plate Tectonics40
2. Pollution41



Corners

Activity Ideas

1. Stellar Evolution75
2. Types of Galaxies75
3. Plate Boundaries76
4. Weather Fronts76
5. Rock Types76

Blacklines

1. Celestial Bodies77
2. Rock Types82



Mix-N-Match

Activity Ideas

1. Ocean Floor Features126
2. Identification of Weather Terms126
3. Identification of Planets127
4. Identification of Stars and Constellations127

Blacklines

1. The Atmosphere128

& B l a c k l i n e s



Word Webbing

Activity Ideas

1. Layers of the Earth168
2. Tides168
3. Seasons169
4. Types of Volcanoes169

Blackline

1. The Rock Cycle170



Give One, Get One

Activity Ideas

1. Sea Floor194
2. Earth's History194
3. Evolution of the Solar System.195
4. Conservation195

Blacklines

1. Constellations and Stars196
2. Resources197



More Structures

Agree-Disagree Line-Ups

- Activity Ideas**208
- Blackline** Alternative Energy Fuels211

Fan-N-Pick

- Blackline** Geologic Time218

Mix-Freeze-Group

- Blackline** Earth's Technological Measurements225

Sequencing

- Activity Ideas**231
- Blackline** Earth's Geological History237

Showdown

- Blackline** Mapping248

Telephone

- Activity Ideas** Natural Disasters253

Timed Pair Share

- Blackline** Weather258

Physical Science

A c t i v i t i e s



Find Someone Who

Activity Ideas

1. Newton's Laws Recognition18
2. Simple Machines Recognition18
3. States of Matter Recognition19
4. Types of Energy Recognition19

Blacklines

1. Heat Energy Hunt20
2. Speedy Search21



Pairs Check

Activity Ideas

1. Force Problems42
2. Work Equations42
3. Temperature Conversions43
4. Circuits43

Blacklines

1. Significant Digits44
2. Elements45



Corners

Activity Ideas

1. Types of Waves86
2. Electromagnetic Devices86
3. States of Matter87
4. Newton's Laws87

Blacklines

1. Metric Measurements88
2. Density92



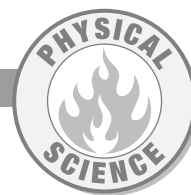
Mix-N-Match

Activity Ideas

1. Simple Machines138
2. Formula Review138
3. Circuit Parts and Features139
4. Electromagnetic Spectrum139

Blackline

1. Waves140



& B l a c k l i n e s



Word Webbing

Activity Ideas

1. Forms of Energy172
2. Magnetism172
3. Mirrors173
4. Alternative Energy Sources173

Blacklines

1. Waves174
2. Archimede's Principle176



Give One, Get One

Activity Ideas

1. Scientific Method198
2. Technology198
3. Acids & Bases199
4. Physical Science Application199

Blacklines

1. Compound Machines200
2. Energy201



More Structures

Agree-Disagree Line-Ups

- Activity Ideas208

Fan-N-Pick

- Blackline Magnetism220

Mix-Freeze-Group

- Blackline Astronomy226

Sequencing

- Activity Ideas231
- Blackline Constructing a Graph240

Showdown

- Blackline Forces250

Telephone

- Activity Ideas Waves254

Timed Pair Share

- Blackline Pollution259

General Science

A c t i v i t i e s



Find Someone Who

Blacklines

1. People Hunt22
2. Lab Bingo23
3. Blank Template24



Pairs Check

Activity Idea

1. Right vs. Wrong Laboratory Procedures46

Blackline

1. Observation/Inference47
2. Blank Template48



Corners

Activity Idea

- Safety96



Mix-N-Match

Activity Ideas

1. Identification of Lab Equipment150
2. Identification of Safety Symbols150
3. Lab Procedural Rules/Techniques151

Blackline

1. Blank Template152



& B l a c k l i n e s



Word Webbing

Activity Ideas

- 1. Lab Equipment178
- 2. Unit Prefixes178

Blacklines

- 1. Lab Awareness179
- 2. Scientific Method181
- 2. Blank Template182



More Structures

Agree-Disagree Line-Ups

- Activity Ideas**208
- Blackline** Alien Life Forms212

Sequencing

- Blackline** Blank Template242

Telephone

- Activity Ideas** Lab Procedures254

Foreword

By Dr. Spencer Kagan

For a number of years, those of us who were pioneering the cooperative learning movement observed and puzzled over an anomaly. The extensive research on cooperative learning revealed that academic achievement gains were as large and as consistent among secondary students as among primary school students, yet implementation of cooperative learning was far greater at the primary level. A large scale meta-analysis involving hundreds of research studies revealed no difference in the effectiveness of cooperative learning for secondary school vs. primary school students — for all students, large, consistent gains in academic and social variables were found.¹ It just was not logical: Logic would dictate that if the evidence in support of cooperative learning was equally strong for primary and secondary, implementation should also be equally strong. But for quite a number of years, cooperative learning flourished at the primary school level and languished at the secondary school level.

It was only belatedly that we realised the problem resided in the resources and trainings we were offering. Those of us who were developing the field of cooperative learning were developing generic cooperative learning methods, but in our workshops and books we never specifically outlined how to apply those methods to understanding the periodic table, the layers of the earth, the difference between speed and velocity, macromolecules, or the nature of a DNA helix. This book, *Cooperative Learning and Science: High School Activities*, goes a long way to remedy that deficit.

Cooperative Learning and Science: High School Activities follows a recent tradition begun in 1998 with the publication of Tom Morton's *Cooperative Learning & Social Studies*.² When that book was published, we were flabbergasted. Almost immediately, the book became one of Kagan Publishing's best sellers. Secondary school teachers were saying, "Finally a book just for me". We followed Morton's publication with two books for secondary school maths: Dina Kushnir wrote *Cooperative Learning & Mathematics: High School Activities*³ and Becky Bride wrote *Cooperative Learning & High School Geometry*⁴. In each case, the response exceeded our expectations. Secondary school teachers were clamoring for cooperative learning resources.

Today, our secondary workshops are now just as popular as our primary workshops. Secondary teachers are responding to the workshops with unbridled enthusiasm, “*Finally a workshop just for me!*” Demand for cooperative learning trainings and resources among secondary school and university professors now rivals the demand among primary school teachers.

Why Has Cooperative Learning Come to Secondary School?

What happened to account for this shift? What brought cooperative learning to secondary school? I can offer six explanations: 1) Students are carrying the cooperative learning message; 2) Students are different today; 3) Employability skills are shifting; 4) Block scheduling; 5) Resources are becoming available; 6) Structures.

Students Carry a Message. A number of years ago, I began doing large trainings. A pattern emerged. First, we would be called to train the primary school teachers. A few years later, we would get a call to train the middle years teachers. Then, a few years later, we would get another phone call. This time it was a request to train the secondary school teachers. What was happening? A few years after we trained the primary school teachers in the cooperative learning methods, the middle years teachers observed a profound difference in students coming from feeder schools where cooperative learning was taking place. The students were more polite, had a more positive attitude toward school, and were more oriented toward achievement. They were, simply put, better students. And

then, a few years later, the secondary school teachers saw the difference and so they wanted training. The students were moving up and bringing the message with them!

Students Are Different. Today’s secondary school students little resemble the students of my generation. I have talked with many older teachers and they confirm: Today’s students are *different*. They report that they cannot get the same positive reaction from students today when they use the same teaching strategies. To engage students today, they have to use far more active and interactive instructional strategies.

When I attended secondary school, we looked up to our teachers. We wanted to please them, and learn from them. What a teacher said was important. There was respect for the teacher, school, and learning. Our teachers and classes were *interesting*. In fact, class was the most interesting thing in our world. Today all of that has changed. Fast-moving violent films, television, music videos, video games and the Internet bombard today’s secondary school students. The teacher and class are no longer the most interesting sources of stimulation. Whereas a lecture was an engaging source of stimulation for my generation, the same lecture is boring for today’s youth — media has upped the ante!

How does that help explain the increased demand for cooperative learning at the secondary school level? Brain science reveals the brain is more engaged during social interaction than any other time.⁵ When we institute cooperative learning, students immediately become engaged. Peer

interaction can compete with the acquired need for fast-moving stimulation; a lecture cannot. Students come to school not to listen to a teacher, but to interact with their peers. Cooperative learning allows students to do what they most want to do. Research reveals that students not only learn more when we use cooperative learning, but they also like school, class and content more. Cooperative learning is the instructional methodology of choice for today's students.

Employability Skills. Consciously and unconsciously, our educational system is preparation for participation in the workforce. Traditional methods in which students were told what to do and expected to do it paralleled the traditional workplace in which a boss told the employee what to do and the employee was expected to do it. Today's workplace is different. High technology has led to specialisation which has led simultaneously to independence and interdependence. Employees with their very specialised skills are given tasks, but are expected to use creativity and initiative in fulfilling them. The boss cannot possibly know all the specialised skills of today's employees; the employees have to make decisions on their own. At the same time, they have to work with one another. No one person can design and make a state-of-the-art computer. Today's workplace is dominated by teamwork. Teams work on components, coordinating their efforts with other teams. Over 70% of today's employees work in teams as part of their regular job, and the number is increasing.⁶ Today's teachers and administrators realise that the traditional approach to structuring a class (teacher as boss) will not prepare students to

make decisions, work creatively, and acquire teamwork skills. Cooperative learning is becoming popular at the secondary school level partly because it prepares students for the kind of world they will enter.

Resources. The increased demand for secondary resources and trainings in cooperative learning is supported also by more responsive publications and workshops. *Cooperative Learning & Science* is another milestone along that path. With their *Cooperative Learning & Science*, Michael, Angela, and Janina are doing for secondary school science teachers exactly what Dina Kusnir did for secondary school maths teachers. They show how selected cooperative learning structures can be used across the curriculum to generate powerful, engaging lessons with any content. In the last few years, we have begun providing subject-specific workshops for secondary teachers. Rather than interacting with a primary teacher to discuss how to use a structure, secondary teachers process cooperative learning methods by interacting with fellow secondary teachers in their own content specialty.

Structures. Secondary teachers are learning the power of structures. Structures are an easy and effective approach to cooperative learning. Let's take a closer look at the many advantages of Kagan Structures.

Kagan Structures

Older models of cooperative learning were lesson-based. That is, the model demanded that teachers design and implement complex cooperative learning lessons. The message with the lesson-based approach: Stop teaching

the way you have been teaching, we will show you a better way. It is difficult, if not impossible, to spend each night planning brand new lessons while maintaining content integrity.

In contrast to the lesson-based approach, the structure-based approach to cooperative learning provides a very different message: Keep teaching what you have always taught; keep your existing lessons. Structures will allow you to make those lessons more engaging, efficient and successful. Structures demand little or no special planning time and do not demand a radical transformation of existing lessons. Structures are simple instructional strategies that make a world of difference. For those of you new to the concept of structures, let me provide an example.

For purposes of comparison, let's contrast RallyRobin with the traditional way we have students respond to questions in our classroom. RallyRobin is one of the simplest of all the Kagan Structures — it can be used with no preparation and no change in content, at almost any point in a lesson. In a RallyRobin, students in pairs take turns speaking, usually naming things from a list, recalling or generating ideas. In a science class, RallyRobin may be used to have students take turns generating possible alternative explanations for a phenomenon.

For our comparison, let's look into the classrooms of two different teachers who want their students to review the inert elements:

- **Traditional class:** The teacher says, "*Without looking at the periodic table, who in the class can name an inert element?*" Students then raise their hands to be called on.
- **Kagan Structures:** The teacher uses the structure RallyRobin. He says, "*Turn to your partner and do a RallyRobin naming inert elements without looking at the periodic table.*" Each student then takes a turn with his/her partner, each naming an element and then waiting for his/her partner to name the next one.

These two teachers have structured the interaction in their classroom differently — they are using different structures.

What are the benefits of using the cooperative structure RallyRobin rather than the traditional structure? The list is long. To name a few:

- Every student in the class generates several answers, as opposed to a selected few students generating one answer each
- All students are engaged so none tune out or get off task
- Half the class is answering at any one moment as opposed to only one student in the class
- The teacher can authentically assess students' knowledge by listening in to a randomly selected group, instead of just hearing from the high achievers
- Students like the variety; they say the structures are fun
- Students with answers become a resource rather than being put down as "know it alls" or "brown nosers"

- Students feel mutually supportive, not in competition with one another for teacher approval
- Test scores go up
- Students acquire teamwork skills and attitudes

This last point, that students learn to work in teams, is particularly important for science instruction. The day of the mythical “lone scientist” has come and gone. As science has become more sophisticated and complex, scientific inquiry is conducted increasingly by interdependent teams. The sole authorship of science papers was first replaced by co- and multiple authorships. Today, numerous interdependent teams, often in different labs, coordinate efforts and conduct science. As science continues to build on the complex methodologies and findings that are being established, interdependence among scientists will become even more the norm and teamwork skills will be prerequisite for full participation in the scientific community.

The structures you find in *Cooperative Learning & Science* are carefully selected to improve science instruction. They represent a range of types of structures.

Pairs Check is used following an introduction of a new skill; it is guided practice to master the skill. The skill can be anything from solving a type of equation to adjusting the flame on a Bunsen burner. The advantage of Pairs Check is that students get immediate supportive feedback and coaching; they do not have to wait until after you mark papers. An added advantage for teachers, of course, is that Pairs Check eliminates a great deal of unnecessary marking of worksheets.

Find Someone Who is active practice in consulting. Instead of treating a text as the ultimate or sole source, students find consultants in the class to help them find answers. An added benefit of Find Someone Who is that it allows students to get up from their desks and move around the room; a welcome break, especially if you are teaching a long session.

Mix-N-Match also energises the class through movement. It is geared to the type of content that typically comprises the matching part of an exam. *Cooperative Learning & Science* provides ready-made blackline masters for Mix-N-Match. (Hint: Copy the cards onto coloured card and laminate them before cutting them to make an enduring set that can be used year after year.)

Corners allows students to express their preferences and to know and appreciate their classmates. In a secondary science class, the most powerful form of Corners is to have each member of the team go to a different corner of the room, gaining expertise from classmates that he/she can share after returning to teammates. Corners leads to content mastery, but in the process provides a great boost to self-esteem and peer acceptance because each teammate makes a unique, valuable contribution.

Give One, Get One also allows students to become experts, then share their expertise with others. An answer I “Get” from a classmate becomes an answer I “Give” to another classmate, and to my teammates at the end of the activity. In the process, I learn more. As we teach, we learn.

Word Webs are a wonderful exercise in the type of relational thinking core to so much of science. Important fields of science aim at understanding non-linear, mutually interactive webs of relationships. Traditional outlines cannot easily depict those relationships. How do I show in an outline a link between IIA1 and IIC2? In a Word Web, the relationship is expressed with a simple arrow.

Agree-Disagree Line-Ups is a structure to use when discussing science related ethics. Science education today cannot escape value issues. We can make a human from an egg of an unborn fetus. But should we? We can tell if someone is prejudiced (whether he/she knows it or not) by doing a brain scan of the amygdala as he/she is shown pictures of faces of people of different races. But should we? Should brain scans that reveal amount of impulsivity be considered in determining early parole for prisoners who have committed violent crimes? Today's students will shape the future of our society as they vote on value issues like these. It is not our job as science educators to teach values, but it is our job to have students reflect on and think more deeply about the value issues inherent in our content. The perfect structure for this is Agree-Disagree Line-Ups. As students come to listen to, understand, and respect points of view different from their own, they become more thoughtful and articulate.

Avoiding Two Sins

There are two ways to go wrong as we have students work together to do science: Group Work and Group Marks. It not hard to find teachers who report, *"I tried cooperative learning and it did not work!"* What they don't realise is

that they violated basic principles of cooperative learning, probably by doing group work or by using group marks. The authors of *Cooperative Learning & Science* gracefully side-step these traps.

Group Work is unstructured interaction. A teacher gives students a problem or a task and tells them to work together. The results are predictable and terrible. The high achiever, not wanting for the group to do poorly, takes over. Resentments build on both sides: The high achiever thinks, *"I had to do it all"*; the low achiever feels, *"I was not included"*. Unstructured work in groups is wishful thinking. We hope the students will all participate and learn, but we have not taken responsibility for creating those outcomes. Structures are carefully designed to avoid the pitfalls of group work; they structure interaction to include the PIES principles: Positive Interdependence, Individual Accountability, Equal Participation and Simultaneous Interaction.⁷ Each teammate participates about equally and is accountable for his/her contribution. The structures in *Cooperative Learning & Science* are carefully designed to include the PIES principles and avoid the trap of group work.

Group Marks also violate basic principles of cooperative learning and produce lamentable outcomes. The teacher gives a project to a group and then gives the project a mark. Each person on the team gets that mark for the project. Predictably, group marks produce free riders. Johnny does no work at all on the project, but gets a good mark because his teammates completed a first-rate project. Or, Johnny does a great job on the project, but gets a lower mark because Susie

did a poor job on her part. Group marks are unfair and create a backlash against cooperative learning.⁸ Cooperative learning is designed to promote learning; if we want to assess the effects of our instruction, there is no alternative to assessing the effects on individual learners. *Cooperative Learning & Science* provides structures for learning; it avoids the trap of group marks.

An Appreciation

Michael Michels, Angela Manzi, and Janina Mele have made an important contribution to the process of releasing the power of cooperative learning in secondary school classrooms. With *Cooperative Learning & Science*, any secondary school science teacher will find ready-made, proven activities. Be

careful, though. The book should come with a warning label: *Caution Advised. Use of the Enclosed Activities Is Likely to Lead to an Addiction!* All it will take is trying a few of these activities in your own classroom and observing the reaction and performance of students, and you will get hooked. The wonderful thing, though, is that once you have mastered a structure, you will find it easy to generate your own activities for any content you teach. *Cooperative Learning & Science* is a springboard to a new way of teaching. Try it. You may well get hooked.

Good luck,

Spencer Kagan
June 14, 2003

References

- ¹ Johnson, D.W., Maruyama, G., Johnson, R. Nelson, D. & Skon, L. *Effects of cooperative, competitive and individualistic goal structures on achievement: a meta-analysis*. Psychological Bulletin, 1981, 89, 47–62.
- ² Morton, T. *Cooperative Learning & Humanities*. Melbourne, Australia: Hawker Brownlow Education, 2007.
- ³ Kushnir, D. *Cooperative Learning & Mathematics: High School Activities*. Melbourne, Australia: Hawker Brownlow Education, 2006.
- ⁴ Bride, B. *Cooperative Learning & High School Geometry*. Melbourne, Australia: Hawker Brownlow Education, 2006.
- ⁵ Carter, R. *Mapping the Mind*. Berkeley, CA: University of California Press, 1998.
- ⁶ Filipczak, B. Industry Report. *What do workplace teams do?* Training Magazine, 1994, 31(10), 59–65.
- ⁷ Kagan, S. *Cooperative Learning*. Melbourne, Australia: Hawker Brownlow Education, 2007.
- ⁸ Kagan, S. *Group grades miss the mark*. Educational Leadership, 1995, 52(8), 68–71.

2 Pairs Check

In pairs, students take turns solving problems. After every two problems they check answers and celebrate with another pair.

- 1** In teams of four, shoulder partners are formed. Partner A in each pair does the first problem, talking out loud. Partner B watches and coaches. Partner B praises.
- 2** Reverse roles: Partner B does the second problem. Partner A watches, coaches and praises.
- 3** Pairs check with their face partners after every two problems. Teammates coach and correct if needed.
- 4** The team celebrates after reaching agreement on the two problems.
- 5** Shoulder partners do more problems, continuing to check with their face partners after every two problems.

Student Instructions:

Pair up within your team. Partner A will answer the first problem while Partner B coaches. Partner B helps if necessary and praises Partner A when both agree. Partner B solves the next problem while Partner A coaches. Once both problems are finished, check with the other pair from your team. If you have different answers, determine which is correct. When you all agree, circle the check mark to the right and give a team handshake. Complete the problems in the same fashion.

Pairs Check Activities & Blacklines



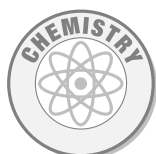
Biology

A. Activity Ideas

1. Transcription/Translation30
2. Reactions of Photosynthesis30
3. Terms of Cell Structures31
4. Population Genetics (Hardy Weinberg Equations) .31

B. Blackline Masters

1. Genetics32
2. Innate or Learned?33



Chemistry

A. Activity Ideas

1. Balancing Equations34
2. Significant Digits/Maths Operations34
3. Naming Organic Molecules35
4. Drawing Structural Formulas35

B. Blackline Masters

1. Stoichiometry36
2. Formulas37



Earth Science

A. Activity Ideas

1. Astronomical Unit Conversions38
2. Half-Life Radioactive Problems38
3. Phases of the Moon39
4. Scientific Notation and Maths Operations39

B. Blackline Masters

1. Plate Tectonics40
2. Pollution41



Physical Science

A. Activity Ideas

1. Force Problems42
2. Work Equations42
3. Temperature Conversions43
4. Circuits43

B. Blackline Masters

1. Significant Digits44
2. Elements45



General Science

A. Activity Idea

1. Right vs. Wrong Laboratory Procedures46

B. Blackline Masters

1. Observation/Inference47
2. Blank Template48



Pairs Check

Biology Activity Ideas

1. Transcription/Translation

Objective: Students will work in pairs to solve and check one another's work for problems relating to protein synthesis.

<p>ATCGCAT</p> <p>Transcribe to mRNA</p> <p>_____</p>	<p>AUG CCG UCA UAA</p> <p>Translate to the amino acid sequence</p> <p>_____</p>	<input checked="" type="checkbox"/>
---	---	-------------------------------------

2. Reactions of Photosynthesis

Objective: Students will work in pairs to solve and check one another's work for problems relating to the reactions of photosynthesis.

<p>The compound produced as a result of the light reactions is</p> <p>_____</p>	<p>The number of ATP molecules produced in the light reactions are</p> <p>_____</p>	<input checked="" type="checkbox"/>
---	---	-------------------------------------

3. Terms of Cell Structure

Objective: Students will work in pairs to solve and check one another's work for problems relating to cell structures and organelles.

The protein factories are known
as

The lysosome is
responsible for:



4. Population Genetics

Objective: Students will work in pairs to solve and check one another's work for problems relating to Hardy-Weinberg & Genetics Probability.

The Hardy-Weinberg
Equation is

If 50% of the population is het-
erozygous for a trait, what is the
frequency of the recessive allele?





Genetics

Instructions: On a separate sheet of paper, complete the Punnett Squares described.

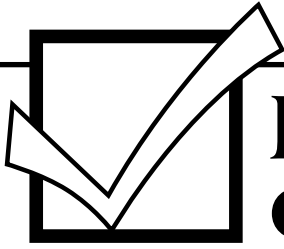
Name: _____

Name: _____

Date: _____

Date: _____

<p>1</p> <p>Complete a Punnett Square for the following cross: GG x Gg</p>	<p>2</p> <p>Complete a Punnett Square for the following cross: GG x gg</p>	<input checked="" type="checkbox"/>
<p>3</p> <p>What would the phenotypic ratio be in a cross between a homozygous green pea plant and a heterozygous pea plant?</p>	<p>4</p> <p>What would the genotypic ratio be in a cross between a homozygous short pea plant and a heterozygous tall pea plant?</p>	<input checked="" type="checkbox"/>
<p>5</p> <p>Complete a Punnett Square with genotypic and phenotypic ratios for the following cross: a purebred smooth pea with a hybrid pea.</p>	<p>6</p> <p>Complete a Punnett Square with genotypic and phenotypic ratios for the following cross: a purebred wrinkled pea with a hybrid pea.</p>	<input checked="" type="checkbox"/>
<p>7</p> <p>Complete a Punnett square with phenotypic ratios for the following cross: two parents that are both hybrids for height and pea colour.</p>	<p>8</p> <p>Complete a Punnett Square with phenotypic ratios for the following cross: one parent that is hybrid for height and pea colour, and one parent that is purebred recessive for both traits.</p>	<input checked="" type="checkbox"/>
<p>Sponge: Create and complete a genetic cross of your own.</p>	<p>Sponge: Create and complete a genetic cross of your own.</p>	



Innate or Learned?

Instructions: Write whether the behaviour is “innate” or “learned” and write your reason for your answer.

Name: _____

Name: _____

Date: _____

Date: _____

1. Coughing	2. Riding a Bicycle	<input checked="" type="checkbox"/>
Type of Behaviour: Reason:	Type of Behaviour: Reason:	
3. Tying Shoes	4. Sneezing	<input checked="" type="checkbox"/>
Type of Behaviour: Reason:	Type of Behaviour: Reason:	
5. Sweating	6. Shivering	<input checked="" type="checkbox"/>
Type of Behaviour: Reason:	Type of Behaviour: Reason:	
7. Having a Fever	8. Eating with a Fork	<input checked="" type="checkbox"/>
Type of Behaviour: Reason:	Type of Behaviour: Reason:	
9. Biting Fingernails	10. Feeling Pain	<input checked="" type="checkbox"/>
Type of Behaviour: Reason:	Type of Behaviour: Reason:	

Sponge: If your pair or team finishes early, then come up with at least five more examples of innate behaviour and at least five more examples of learned behaviour.



Mix-N-Match

Earth Science Activity Ideas

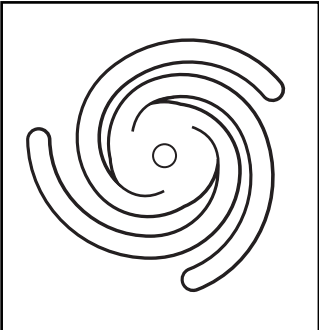
1. Ocean Floor Features

Objective: Students will identify the region of the world with its characteristic ocean floor feature.

Trench	West Coast of South America
--------	-----------------------------

2. Identification of Weather Terms

Objective: Students will identify the weather system and match it with its name or type of weather associated with it.

	Low Pressure System
---	---------------------

3. Identification of Planets

Objective: Students will match a fact about a planet with the name or picture of the planet.

Visible
surface
has a large
red storm.



4. Identification of Stars and Constellations

Objective: Students will match pictures or facts with different celestial bodies and constellations in the universe.

Orion, The
Great
Hunter

