

1  **ISGE**

INTEGRATED SCIENCE

GENERAL EDUCATION

2  **THIS PRESENTATION**

- ▶ **Part I: Science G.E. Problems ISGE Must Answer**
- ▶ **Part II: Overview Course Structure: Place in Curriculum**
- ▶ **Part III: Nine Special Motivational Multimedia Features**
- ▶ **Part IV: Multimedia Efficacy and Industry Data**
- ▶ **Part V: Nine Special ISGE Pedagogical Features**
- ▶ **Part VI: Twelve Trademarked Learning Features**
- ▶ **Part VII: ISGE Student Evaluations and Assessment**
- ▶ **Part VIII: ISGE Opportunities for Pre-Service Teachers**
- ▶ **Part IX: Analysis of Course Philosophy & Strategy**

3  **PROBLEMS AND NEEDS
DRIVING G.E. REFORM**

- ⑨ **Very Poor U.S. Science & Math Literacy**
- ⑨ **Very Poor International Ranking in SciTech**
- ⑨ **Exploding Knowledge Base**
- ⑨ **Fragmented Offerings: Call for Integrative Interdisciplinary Courses**
- ⑨ **Breadth without Depth: Need for Both**
- ⑨ **Rising Enrollments - Limited Resources**
- ⑨ **New Student Populations & Expectations**
- ⑨ **Poor Dissemination of Innovations**

4  **DEMONSTRATED INADEQUACIES OF CONVENTIONAL SCIENCE G.E.**

- ⑨ **Dearth of New Teaching & Learning Techniques in Science G.E.**
- ⑨ **Drastically Insufficient Scientific Methods Section**
- ⑨ **Sci G.E. Taught As Watered Down Major's Course**
- ⑨ **Students Take Unlinked Potpourri of Courses**
- ⑨ **Little "Cumulative Effect"; Poor "Sequencing"**
- ⑨ **Connections Not Made for Audience Needing Them Most; Need Organizing Framework of New Concepts**
- ⑨ **Not Connected to Home Majors or Student's Lives**
- ⑨ **Large Classes - Personal Tutoring Impossible**

5  **SYNERGY OF SOLUTIONS**

- ▶ **Easier, More Efficient to Solve Several Related Problems
SIMULTANEOUSLY**

- ▶ **With One Multifaceted Solution, Than Attack Each Separately**

SYNERGY OF EFFORT & BENEFIT

- ▶ **Modern Systems Research Supports This Comprehensive Strategy**

- Can only replace an established system with a much more efficient system ((hypercycle research of Nobel Laureate Manfred Eigen))

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SCIENCE GENERAL EDUCATION

- ▶ **Common Problems - Common Needs**

- ▶ **K-12; 2-Year and 4-Year College; Adult**

- ▶ **ISGE is a Hybrid of Computer-Based Multimedia and Social-Based Courseware**

- For College Undergraduates Everywhere
- For Pre-service Teacher Training
- For In-Service Teacher Workshops
- For Developing Extensive K-12 IntSci Materials

- ▶ **Enabling and Empowering Teachers at all levels**

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PURPOSES OF PRESENTATION

- ▶ **Spread Awareness & Availability of Integrated Science Materials**

- ▶ **Exciting Multimedia CD-ROMs for Your Classroom** (100's sys-sci games; 100's animations)

- ▶ **Possible Expansion of Systems Concepts for Use in STELLA** (12+ new sys processes)

- ▶ **Entrepreneurship: Attraction of Teacher-Authors for ISGE-Based K-12 Text & Class Materials**

- ▶ **Introduction of SIS Alliance to CLE**

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- ▶ **California Framework Recommends Teaching K-12 Science as Integrated Science**

- ▶ **California Framework Contains Verbatim AAAS Chapter 11 on Common Themes (=ISGE IntThemes)**

- ▶ **Yet Little or No Integrated Science K-12 Materials Are Available from Publishers**

- ▶ **Every ISGE Student Works on Yearlong Project As Part of Program and Grade**

- ▶ **Pre-Service Teachers Can Use ISGE Experience to Adapt ISGE to K-12 While Learning**

- ▶ **Five Direct Benefits for K-12 Pre-Service or In-Service Teachers who take ISGE**

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- ▶ **ISGE Students Will Learn Where to Get Integrated Science Materials (e.g. The Learning Exchange)**

- ▶ **ISGE Students Will Learn Tools to Use in Class (i.e. use of computer program STELLA to model systems)**

- ▶ **ISGE Students Will Become Authors of K-12 Texts in Integrated Science and Make Money**

- ▶ **ISGE Students Will Present Papers to NSTA, CSTA**

- ▶ **ISGE Students Will Develop Lesson Plans and Material for Their Direct Use in Job**

- ▶ They Will Become Founding Members of the SIS Alliance
- 10 ☐ **SYSTEMS INTEGRATED SCIENCE (S.I.S.) ALLIANCE**
- ▶ **New Challenges from State and Federal Gov'ts for Teacher Certification**
 - ▶ **Locale-by-Locale, Regional Associations of Three Tier Educational Institutions**
 - ▶ **Grants from the National Science Foundation for Seamless Curriculum from K-12 to Community Colleges to University**
 - ▶ **Another Set of Partners for the Creative Learning Exchange**
- 11 ☐ **FOUR REVOLUTIONS NEEDED**
- ▶ **Needed: Significant Integration of Content**
 - ISGE Completely Reorganizes Sci Curriculum and Sequence
 - ▶ **Needed: Integration of New T&L Methods**
 - Multimedia; Competency-Based; Personal Tutoring
 - Cooperative Learning; Discovery Active Learning
 - ▶ **Needed: An Experiment in Roles & Praxis**
 - For the Student; Real-Life Production, Problem-Solving, Social Contribution; Entrepreneurial Stimulus
 - For the Faculty; >Entrepreneurship and >Mentorship
 - ▶ **Needed: Advances in Use of Assessment**
- 12 ☐ **REVOLUTION IN CONTENT INTEGRATION**
- **THE PRINCIPAL ISGE GOAL**
 - ▶ **Construct A Unique Learning Environment for All Non-Science Students to Achieve...**
 -A Deep Understanding of The Scientific Method, and
 -The Most Important Theories & Mechanisms of
 - ASTRONOMY PHYSICS CHEMISTRY GEOLOGY
 - BIOLOGY COMPUTER SCIENCE MATHEMATICS
- Integrated and Presented Not by Discipline,
but by Common Features Across the Disciplines!*
- ▶ Turns the Conventional Presentation Mode Upside Down
 - ▶ Maintains and Respects the Integrity & Rigor of Each Science
 - ▶ Requires SYNTHESIS at the Most Fundamental Level
 - ▶ Builds In As Many as 30 Aids to Help Students Learn
- 13 ☐
- 14 ☐ **WHY SYSTEMS THEMES UNIFY SCIENCE AND SOCIETY**
- ▶ **ISGE Emphasizes Similarities and Differences Natural and Social Systems**
 - ▶ **The Sciences Study Systems in Nature Apart from Humans**
 - ▶ **Humans Build Systems of Themselves and Artefacts**
 - ▶ **BUT BOTH ARE COMPLEX SYSTEMS**
 - ▶ **Both Tend to Use the SAME Processes and Behaviors If Studied on the Generic or Abstract Level**
 - ▶ **So Throughout the Course We Will Explain When Their Inherent Processes are Similar and When Different**
- 15 ☐ **REVOLUTION IN**

CONTENT INTEGRATION

◆ ONLY 3 TYPES OF INTEGRATIVE THEMES...

◆ ...to achieve synthesis & keep learning manageable...

◆ ...General Systems Concepts

- Only Three Studied Per Quarter; Each Provides a General Overview
- Focus on Only Nine of the Most Fundamental Mechanisms to Both Natural & Social Systems Over the Entire Year; All Interrelated

◆ ...The Scientific Method; Its Tools & Techniques

- Common to All 7 Sciences; Very Detailed Coverage vs. Conventional
- 2-3 MMModules Per Quarter; Nine by End of Year of Study

◆ ...Decision Theory and Statistics

- Important to Students and Most Applications of Science
- Threaded Throughout Entire Year in Labs & Training Sessions

16 INTEGRATIVE THEMES

17 REVOLUTION IN

CONTENT INTEGRATION

WHY USE SYSTEMS CONCEPTS TO TEACH SCI?

- ◆ Highly Transdisciplinary; Same Process Found in Key Phenomena of All Seven Sciences
- ◆ Enable Simplification & Integration at Very Fundamental Level
- ◆ Focus on Processes that Are At the Source of Natural Systems
- ◆ Bridge Natural & Socio-Economic, Psych. & Political Sciences
- ◆ Bridge Theory and Applications
- ◆ Provide an Intuitively Appealing Framework to Organize Learning
- ◆ Cal-Poly Institute has studied Systems Concepts as Common Features for 26 Years; Awarded ca. \$2M of Grants

18 REVOLUTION IN

CONTENT INTEGRATION

⑨ SUPPORT for use of SYSTEMS CONCEPTS as INTEGRATIVE THEMES

- ⑨ Dramatic Increase in Recognition of Systems-Based Mechanisms in Primary Science Literature of All 7 Sciences
- ⑨ Empirical Evidence Presented by CP Institute to ISSS Using Computerized Data Bases
- ⑨ Chapter 11, “Common Themes” of Project 2061 Report; Demanded by All Five Panels
- ⑨ A National-Level, Three-Year Study by 100’s of Scientists, Engineers, and Educators in Five Panels
- ⑨ National Council on Science and Technology Educ.
- ⑨ American Association for the Advancement of Science

19 REVOLUTION IN

CONTENT INTEGRATION

CASE STUDY APPROACH THROUGHOUT

- ◆ Detailed Case Studies in Each of Seven Sciences for Each Unifying Theme
 - Every Case Study Possesses Features of the Integrative Theme; e.g. for “Hierarchies In...”
Ast(1);Phys(3);Chem(5);Geo(2);Bio(6);CS(3);M(4)
- ◆ More than 250 CASE STUDIES Over Year of Study
- ◆ Provide Breadth, Rigor, & Depth Simultaneously
- ◆ Students Study Integrative Theme MMModule First
- ◆ Then Discipline-Based Case Study Modules that Show that Integrative Process in Each of the Seven Sciences
 - This Learning Cycle Repeats Every Two Weeks of Yearlong Course

20 CASE STUDIES

21 STRUCTURE OF ISGE

COURSEWARE I.

- ▶ **Three Fully-Integrated Courses In An Uninterrupted Series**
 - Fall/Winter/Spring Quarters; Increases Topics Covered
- ▶ **All Science G.E. Completed in 1 Yr.**
 - Reduces Attrition; Enables Significant Compaction; Provides Consistent Learning Framework; Increases Cumulative Build
- ▶ **16 Units of G.E. (5,5,6) + 4 Unit Credit for Statistics = 20 Units; Includes 1 Unit of Lab**
 - Attracts and Rewards Students; Increases Efficiency of Both Faculty and Student Time

22 **STRUCTURE OF ISGE COURSEWARE II.**

STUDENT ACTIVITIES: WEEK AT-A-GLANCE

- ▶ **2-3 Computer-Based Multimedia Modules per Week**
 - Independent Study Habits; Master of Own Time; Can Even Do At Home
 - Student Choice from Extensive Case Study Library; Dozens of Special Features
 - Motivational; Self-Paced Mastery; Personal Tutoring; Better Integration
- ▶ **One Small-Group Discussion Session per Week**
- ▶ **One Skill-Training Session per Week (Math & Statistics)**
- ▶ **An Interdisciplinary Lab Experience Every 2 Weeks**
 - 7 experiments on each Integrative Theme; 1 per Science
- ▶ **All Four Learning Experiences Focus on the Same Integrative Theme and Set of Case Studies for a 2-3 Week Cycle**
 - Repetition with Variety Increases Learning; Maintains Interest and Enthusiasm

23 **WEEKLY STUDENT ACTIVITIES**

24 

NINE SPECIAL MULTIMEDIA FEATURES

- ▶ **Stunning Scientific Graphics**
- ▶ **Numerous Animations** (SciProcesses in Action; See Unseeable)
- ▶ **Virtual, Student Controlled Fly-Thru's**
- ▶ **Recent, Exciting Scientific Discoveries**
- ▶ **Uses Delight in Travel for Motivation**
- ▶ **Moderate Levels of Interactivity**
- ▶ **Mind-Expanding Learning Metaphors**
- ▶ **Multimedia-Based At-A-Glance Overviews**
- ▶ **Numerous Choices for Personal Pathways**

25 **INTEGRATED SCIENCE - MULTIMEDIA FEATURE #1**

Science Graphics

- ▶ **Intriguing Images that Delight the Senses**
- ▶ **Beautiful Pictures that Command Attention**
- ▶ **Pictures that Simultaneously Focus the Mind & Teach**
- ▶ **Distill Key Points of a Lesson in Human-Oriented Delivery System**
- ▶ **Make A Complex Idea Clear and Simple**
- ▶ **"A picture is worth a thousand words"**

- ▶ "Tell Me and I Will Learn 45%; Show Me and I Will Learn 75%"

26  **STUNNING GRAPHICS**

27  **INTEGRATED SCIENCE - MULTIMEDIA FEATURE #2**

Science Animations

- ▶ Teach While They Delight the Senses
- ▶ Students Watch A Process Take Place As It Happens
- ▶ Greatly Enhances Understanding of Hard-to-Perceive Dynamics
- ▶ Enables Comparison of Actions at Different Levels of Detail
- ▶ Shows Phenomena Too Dangerous or Too Remote, Too Slow or Too Fast to Witness
- ▶ Integrates: Puts Lots of Details Together in One Flow

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Virtual Fly-Thru's

- ▶ QuickTime VR Movies Called-Up at Will for Self-Guided Exploration; Freedom to Follow Curiosity
- ▶ Increases Interest & Enthusiasm; Active Learning
- ▶ Students Control What To Look At Next by Clicking On Next Object
- ▶ Allows for Repeated Inquiries; Each a New Pathway
- ▶ Also FlyThroughs™ of the Interior of Stars; Planet Interiors; Atomic Structure; Spiral Galaxies; Anatomy
- ▶ FlyThroughs™ of the MindSpace or Knowledge Map of the Systems Processes Used as Integrative Themes

29  **CYCLES IN ASTRONOMY**

30  **INTEGRATED SCIENCE -
MULTIMEDIA FEATURE #4**

Most Recent Science Discoveries

- ▶ "Hot Off The Press;" Captured in a Graphic
- ▶ The Very Latest Advances in Scientific Imagery Causing Excitement in the Scientific World
- ▶ ISGE Has Special Arrangements with and Special Contacts at:
 - ▶ NASA, JPL, NPS, USGS, NOAA, USFG, USF, AG.....
- ▶ SIS Alliance Will Maintain a Website for K-12 Teachers Explaining the Newest Discoveries
- ▶ A Helpful Service for Entire Career; Keeps on Helping

31  **RECENT SCIENTIFIC DISCOVERIES**

32  **INTEGRATED SCIENCE - MULTIMEDIA FEATURE #5**

Everyone Likes to Travel !!

- ▶ Study Motivator; Enables Student to Follow Curiosity
- ▶ Extensive Travel...
 - ...Through Space
 - ...Up and Down Scales of Reality
 - ...Across Time
 - ...Across Dimensions
- ▶ Witnessing What is Impossible to Witness
 - ...By Time Compaction

- ...By Time Lapse
- ...By Time Speed-Up

33 **INTEGRATED SCIENCE -
MULTIMEDIA FEATURE #6**

Interactivity Promotes Active Learning

- ◆ **Interactivity is Premium in Science Education; Now Required by Most Funding Agencies**
- ◆ **Multimedia Data: In 14 Exp'ts in Higher Education "Interactive" Shown Much More Effective Than Conventional Passive**
- ◆ **"Tell me and I'll learn 45%; show me and I'll learn 75%; "actively experience" and I'll learn 100%"**
- ◆ **Moderate Levels Most Costly to Produce; \$100,000/Hr.**

34 **VIRTUAL ZOOS**

35 **INTEGRATED SCIENCE - MULTIMEDIA FEATURE #7**

Intriguing Learning Metaphors

- ◆ **Teach Student What Happens When They Learn**
- ◆ **Give Students an Overview Image of Education**
- ◆ **Shows The Value of Education As It Happens**
- ◆ **Informed by and Based on Modern Brain Research & Neural Net Theory; Used as Learning Metaphor**
- ◆ **Aggressive Use of Scientific Data on Human Learning**
- ◆ **The InfoNet Traveler™ as Yearlong Metaphor**
- ◆ **The Species Brain as Yearlong Metaphor**

36 **INTEGRATED SCIENCE - MULTIMEDIA FEATURE #8**

MM Surveys, Overviews, Comparisons

- ◆ **Can Use the Power of Multimedia to Show Students Several Related Items in a Designed Juxtaposition that Reveals and Emphasizes Key Details**
- ◆ **Can Use the Power of Multimedia to Reveal a View of the "Territory" from an Instructive Distance**
- ◆ **Diverse Material Presented At-A-Glance Helps Students Achieve Synthesis and Integration**
- ◆ **Diverse Material Presented At-A-Glance Helps Students Achieve Understanding**

37 **INTEGRATED SCIENCE -
MULTIMEDIA FEATURE #9**

Many Choices To Maintain Interest

- ◆ **Keeps Students Involved, Not Passive, Bored; They Choose What Most Interests Them**
- ◆ **Not Page-Turner Multimedia; Verboten**
- ◆ **Student Feels Less Bombarded with Massive Amounts of Facts**
- ◆ **Trains Students to Think for Themselves**
- ◆ **Shares Responsibility of Learning with Students**

38 ☐ **MULTIMEDIA EFFICACY DATA**

WHY USE MM MODULES?

- ▶ “Training Time is Commonly Reduced by 50%”
- ▶ “Nearly 30% Increase in Retention”
- ▶ “100% Consistency of Presentation”
- ▶ Dramatic Increase in “Accessibility & Distribution”
- ▶ Long Period of Faculty Incubation Enables More Synthesis & Integration

39 ☐ **MODULES**

40 ☐ **MULTIMEDIA EFFICACY DATA**

WHY USE MM MODULES?

- ▶ 147 Expts; Tested “Interactive” vs. “Standard”; All Cases; 50th%ile --> 69th%ile
- ▶ 14 Higher Education Expt’s; Inter. over Conv.; 50th --> 75th%ile
- ▶ Effect Sizes for 27 Knowledge Outcomes averaged 0.35 Standard Deviations
- ▶ Effect Sizes for 20 Performance Outcomes averaged 0.35 Standard Deviations

41 ☐ **MULTIMEDIA EFFICACY DATA**

WHY USE MM MODULES?

- ▶ Average Effect Size for Inter. Videodisc in Colleges = 0.69 standard deviations
- ▶ Average Effect Size for CAI in Colleges = 0.26 sd
- ▶ Average Effect Size for CAI in Adult Educ. = 0.42 standard deviations
- ▶ Within Group Variability in Grades Earned Smaller in Interactive over Conventional
- ▶ Using 13 Cost Ratio’s; averaged 36 % less cost
- ▶ Student Time Saved averaged 31 %

42 ☐ **MULTIMEDIA INDUSTRY DATA**

WHY USE MM MODULES?

- ⑨ Home Education Software (from 1993-94)...project a 128 % increase
 - the fastest growing software growth category
- ⑨ Home Education Software (1st Qtr, 1994) = \$89.7 Million
- ⑨ Add Training Software to get a \$4.3 Billion Industry by 1998 (Actually reached \$80 Billion)
 - (Information Workstation Group)
- ⑨ Presumably Students Will Have CD-ROM Drives at Home

43 ☐ **NINE SPECIAL LEARNING FEATURES SUMMARY**

- ▶ 1. Compaction of Info by Integration: Learn One, Know Many; Repetition with Variety
- ▶ 2. Stepwise Refinement Technique
- ▶ 3. Links, Connections; Information in Context

- ▶ 4. Bridges, Applications; Information of Significance
- ▶ 5. Numerous Games & Exercises Expand Study Time
- ▶ 6. Electronic Knowledge Maps Build Understanding
- ▶ 7. Electronic Glossary Function
- ▶ 8. Cumulative, Collaborative Learning Environment
- ▶ 9. Comp. Managed Instruction; Immediate Feedback

44  **INTEGRATED SCIENCE - INNOVATIVE LEARNING FEATURE #1**

Information Integration and Synthesis

- ▶ **Selection of Information**
 - Multiyear, Intensive Study of What to Include/Exclude
 - Guarantors of Coverage of Most Intro Disc. Topics & Disc. “Standards”
- ▶ **Compaction of Information**
 - Extensive Interconnection of Material; Allows More Material/Time
- ▶ **Pre-Learning Organization of New Material**
 - Knowing Theme Features Prepares Students to Receive Case Studies
 - All Case Studies per Integrative Theme Presented With Same Features
- ▶ **Teaches Student Premiere Focus of 21st Century Educ.**
 - Only Curriculum that Teaches How to Synthesize and Integrate with Tools Specifically Designed for Synthesis & Integration Skills Trained

45  **INTEGRATED SCIENCE - INNOVATIVE LEARNING FEATURE #2**

Stepwise Refinement

- ▶ We Build Complex Science Structures Step-by-Step
- ▶ Add Only One Step At A Time To Simplify & Bring Student Along
- ▶ Added Feature Explained At Each Step
- ▶ Stepwise Refinement Promotes Understanding
- ▶ Stepwise Refinement Enables Details & Depth
- ▶ Stepwise Refinement Helps A Wider Range of Students with Different Learning Styles Master Material
- ▶ As A Learning Method, Stepwise Refinement Mimics Some of the Integrative Themes

46  **STEPWISE REFINEMENT**

47  **INTEGRATED SCIENCE - INNOVATIVE LEARNING FEATURE #3**

Science Games & Exercises

- ▶ Numerous Games & Exercises Promote Learning & Expand StudyTime
- ▶ Students Love to Play Computerized Games
- ▶ Students Need to Drill to Learn
- ▶ Games Make Repetition Fun
- ▶ Repetition with Endless Variety Enhances Learning
- ▶ "tell me and I'll learn 45%; show me and I'll learn 75%; “actively experience” and I'll learn 100% (let me play with it and I'll remember forever)

48  **GAMES**

49  **INTEGRATED SCIENCE - INNOVATIVE LEARNING FEATURE #4**

On-Line Automated Quizzes

- Ⓢ Set By a Random Timer Internal to Program
- Ⓢ At Unexpected Intervals Student is Asked From 1-3 Short Questions...
 - ...About What Features of the Integrative Theme Are Illustrated in the Material Before Them at the Moment

- ...Helps Students Focus on Major Learning Objectives of Module
- ...Increases Attention and Directly Contributes to Learning At Same Time

- ⑨ **Questions Are Presented in a Graphic Mode, Not By Text; Answers Also Involve Clicking on Graphics**
- ⑨ **If Student Answers Incorrectly; Program Provides Clues Leading to a Correct Answer & a Consultant**

50  **INTEGRATED SCIENCE - INNOVATIVE LEARNING FEATURE #9**

Computer Managed Instruction

- ▶ **Instant Update of Student Score; Can Be Asked For At Any Time**
- ▶ **Context-Dependent Re-Routing to Low-Score Topics**
- ▶ **Mastery Milestones Identified**
- ▶ **Summary Class Data for Students**
- ▶ **Instant Class Data for Faculty for Assessment and Assignment of Grades**
- ▶ **Vast Amounts of Assessment Data Available**
 - **Authorware Monitors >100 Variables on Student Activity During Their Progress Through Multimedia Modules**

51  **INTEGRATED SCIENCE - INNOVATIVE LEARNING FEATURE #8**

Cumulative Learning

- ▶ **Five Year Design of Storyboards for MMModules**
 - **Enables Careful Study & Restudy of Sequence Build of Key Topics for Within Discipline and Cross-Disciplinary; Prerequisites**
 - **Enables Planned Reinforcement Across Science Topics that Cannot be Accomplished in Separate, Unrelated Conventional Courses**
- ▶ **Coherent Year of Courseware Allows Planned Building on Past Coverage While It Is Still Fresh**
- ▶ **Labs, Discussion Sessions, Skill-Training Sessions Allow for Collaborative-Cooperative Learning**
- ▶ **Applications to Personal Life & Society Adds A Needed New Dimension to Cumulative Learning**

52  **INTEGRATED SCIENCE - INNOVATIVE LEARNING FEATURE #7**

Popular Science Library

- ⑨ **Learning Modules Incorporate Tricks of the Trade Found in Popular Science Books**
- ⑨ **Popular Science Books Specifically Introduced to Students Throughout Year of Coursework**
- ⑨ **Physical Popular Science Library Present in Development Room and Computer Learning Lab**
- ⑨ **Encourage Students to Develop Habits of Reading Popular Science Books**
- ⑨ **Encourage Students to Develop Habits of Reading Popular Science Journals and Science News Reports**

53  **INTEGRATED SCIENCE - INNOVATIVE LEARNING FEATURE #4**

Application and Significance Commands

- ▶ **For Most Topics, Student May Invoke a Command to See Its Application to Their Major or to Human Affairs**
- ▶ **Program Remembers Student's Major; Presents a Screen Explaining the Practical Application of SciTopic**
- ▶ **For Most Topics, Student May Invoke a Command to Explore the "Significance" of the Topic Under Study**

- ▶ Program Presents a Short Film Clip of a Mentor Explaining the Importance of the Topic Under Study

54  **INTEGRATED SCIENCE - INNOVATIVE LEARNING FEATURE #9**

IntelliTutor As Helper

- ⑨ “Intelligent” Tutors are Helper Programs That are Condition Sensitive
- ⑨ They “know” from variables where in the program a student is, and what they are having problems with...
- ⑨ They “know” from variables what a student might need at the point of time they are invoked
- ⑨ They provide alternatives for student action

55  **TWELVE INNOVATIVE LEARNING TRADEMARKS**

- ▶ 1. The Cube Companion™ Control System
- ▶ 2. The InfoNet Traveler™
- ▶ The TimeTunnel Traveler™
- ▶ 3. Links™, Connections™, Bridges™
- ▶ 4. The Electronic Knowledge Mapper™
- ▶ 5. The National Park Virtual Visitor™

56  **TWELVE INNOVATIVE LEARNING TRADEMARKS**

- ⑨ 6. Virtual Zoo’s™ for Exploration
- ⑨ 7. Encyclomedia Function™
- ⑨ 8. Virtual Interviews™
- ⑨ 9. The Lifework Integrator™
- ⑨ 10. The Groupwork Integrator™
- ⑨ 11. The Integration Toolkit™
- ⑨ 12. Experiencing Wisdom™

57  **INTEGRATED SCIENCE - UNIQUE LEARNING TRADEMARK #1**

The Cube Companion™

- ▶ Unique, Innovative Control Panel Found Nowhere Else
- ▶ Very Dynamic; Very Small Space
- ▶ 54 Possible Commands Give Maximum Control and Maximum Flexibility to Student
- ▶ Can Be Invoked At Any Time; Sent Away At Will
- ▶ “Companion” Because It Will Have Several Different Personalities That Can Be Selected By Student
 - Aggressive CC; Sentimental CC; CC With an Attitude; All by Sounds
- ▶ Cardboard Foldout Given to Student on First Day of Class

58  **INTEGRATED SCIENCE - UNIQUE LEARNING TRADEMARK #3**

The InfoNet Traveler™

- ◆ Student Controlled Vehicle for Travel Thru...
...the SPECIES BRAIN
- ◆ Enhances Student Ability to Explore
- ◆ A Physical Metaphor for the Act of Learning
- ◆ Each Control Console in the Traveller Allows a Different Type of Travel to Explore SciTopics
- ◆ Nine Consoles for Travel through....
 - * Space
 - * Dimension
 - * Scale
 - * Time

59 **INTEGRATED SCIENCE - INNOVATIVE LEARNING FEATURE #3**

Links and Connections™

- ◆ Modern Brain Research: Learning Occurs Best When New Info is Richly Linked to Previous Info
- ◆ “ISGE Links” Inform Students About Similarities Between Modules
 - E.g. Info on DNA is found under several different systems themes; student can fly to each one at once
- ◆ “Connections” Inform Students About Similarities Between Two of the Sciences
 - This Dimension is Virtually Ignored in Current SciGE; GE Courses are Stand-Alone, Isolated; Yet It Is Proven to be of Paramount Importance for 21st Century Science and Literacy
 - E.g. Recycling of components in biology, chemistry, geology

60 **INTEGRATED SCIENCE - INNOVATIVE LEARNING FEATURE #4**

Bridges and Applications™

- ◆ “ISGE Bridges” Draw Student Attention on Material that is Similar or Related Between the Sciences and Human Systems...Arts, Humanities, or the Professions
 - E.g. Similarities in Chemicals, Computer, and Human Languages
- ◆ “ISGE Applications” Show How Science Theory Became Human System Technology - Makes SciGE Very Relevant to Personal & Societal Life of Students
- ◆ Entire Year of Study = A Richly Interconnected Unity

61 **LINKS, CONNECTIONS, BRIDGES**

62 **REVOLUTION IN CONTENT INTEGRATION**

ANOTHER WAY TO INTEGRATE

LINKS BETWEEN MODULES

- ◆ Students can “jump” easily from module to module, from science to science following links & connections using our programmed “linkage hive”
- ◆ DNA and Chromosomes is covered under SysTh’s Hierarchical Str.; Duality & Symmetry; Flows; and Feedbacks, etc.
- ◆ Continental Drift in Geology is covered under SysTh’s Boundaries & Limits; Flows; Cycles & Oscillations; and Feedbacks

63 **REVOLUTION IN CONTENT INTEGRATION**

ANOTHER WAY TO INTEGRATE

CONNECTIONS BETWEEN THE SCIENCES

- ▶ For Example, the structure and processes involving “information” between Biology and Computer Science
- ▶ For Example, the geological time scale and fossilization process between Biology and Geology
- ▶ For Example, the several BioGeoChemical Cycles
- ▶ For Example, the similarities and dissimilarities between physical and biological sciences
- ▶ For Example, the properties of water in Physics, Geology, Chemistry, and Biology

64 **REVOLUTION IN
CONTENT INTEGRATION**

ANOTHER WAY TO INTEGRATE

BRIDGES BETWEEN SCIENCE & SOCIETY

- ▶ Despite the differences between human and natural systems, **MANY STUNNING SIMILARITIES BIND THEM TOGETHER** and increase understanding and appreciation of both
 - ▶ Notice how this feature answers several of the **NEEDs** described in the beginning
- EXPERIENCING THE WORLD AS ONE !!!**

65 **INTEGRATED SCIENCE -
UNIQUE LEARNING TRADEMARK #7**

Knowledge Mapping™

- ▶ **Map Of the Relations Between Concepts Studied**
 - Knowledge Maps Organize and Simplify Relations At-A-Glance
- ▶ **Student Electronically Builds Map**
 - Puzzling Over Relations Helps Learn The Relations
 - We Provide Convenient “Tools” To Promote KMap Building
 - Dialogue Boxes Make It Easier to Identify Knowledge Bits; Identify Relations; Automated, Optimized Construction of Map Layout
- ▶ **Knowledge Maps Have Multiple Learning Uses**
 - Compare With Other Students’, or Consultant Map; Toggle “Labels” On & Off; Use for Study; Increases Understanding
- ▶ **Will Also Be Used For Navigation and Choice of Entry**

66 **INTEGRATED SCIENCE -
UNIQUE LEARNING TRADEMARK #2**

NATIONAL PARK VIRTUAL TOURS™

- ▶ **Another Unique, Innovative Feature Found Nowhere Else in Educational Multimedia**
- ▶ **Focuses on “Science Processes Illustrated in Our National Parks”**
- ▶ **Student Invokes Interactive Map of Nat’l Parks**
 - Computer “Knows” Location of Campus; Student Asks for Nearest National Park to “See” Natural Process They Are Studying At That Moment; Nearest Parks Blink
- ▶ **Also Marketable as Separate Product**

67 **INTEGRATED SCIENCE -
UNIQUE LEARNING TRADEMARK #5**

Zoo Virtual Tour™

- ▶ Every Student Has Enjoyed Trips to the Zoo
- ▶ A Place to Browse A Wide Range of Variants at Will
- ▶ The Familiarity of the Metaphor Entices Students
- ▶ Each Zoo Is Introduced In An Appropriate MMModule
- ▶ Zoo's Contain More Variants Than Covered in Module
- ▶ Students Can Return To Any Zoo At Will To Explore More
 - The ISGE Encyclomedia™ Zoo of Elements
 - The ISGE Encyclomedia™ Zoo of StarTypes
 - The ISGE Encyclomedia™ Zoo of Subatomic Particles

68  **INTEGRATED SCIENCE - INNOVATIVE TRADEMARKED FEATURE #8**

ENCYCLOMEDIA™ FUNCTION

- ▶ An Automated “Hotword” GLOSSARY
- ▶ Technical Words in Text Are Shown in Color
- ▶ Student Clicks at Will to Find For Each Word:
 - Glossary Definition
 - Associated Graphics from Anywhere in Courseware
 - Associated Animations from Anywhere in Courseware
 - Significance of Technical Word to Course or Discipline Goals
- ▶ Closing Returns Student to Word-in-Context
- ▶ Individual Glossary for Each Modules; or Master Glossary for Entire Year of Study

69  **INTEGRATED SCIENCE -
UNIQUE LEARNING TRADEMARK #6**

Virtual Interviews™

- ▶ Another Unique, Innovative Feature Found Nowhere Else in Educational Multimedia
- ▶ Students Select Question They Want from Scroll List and Video Answering That Question Pops Up
 - Gives Student Feeling They Are Conducting Interview; Follows Their Curiosity; Improves Their Methods of Inquiry
- ▶ Interviews of Our Cal-Poly Students!
- ▶ Founders of the Systems Movement Included
- ▶ Nobel Prize Laureates! Major Scientific Figures
- ▶ Great Historical Figures; Scientists of the Past

70  **CURRENT STATUS - EVALUATION
& ASSESSMENT DATA**

- ⑨ Four Test Course Offerings To-Date On Two CSU Campuses over 3 Years as part of NSF-CLRIT Funding
- ⑨ Ca. 100 Non-Science Students
- ⑨ Student Grades Determined by a 150-pt Midterm, 150-pt Final, 35 Computerized Quizzes; 4 Lab Reports; 10 Knowledge Maps; Attendance-Participation in Small Group Discussions; & 4 Skill Training Reports
- ⑨ >50% Minority; All Class Levels
- ⑨ 175 Assessment Questions Asked per Student for a Total of Ca. 17,500 Questions to date; Measured 101 Identifiable Parts of ISGE for Educational Efficacy

71  **ISGE EVALUATION and ASSESSMENT**

- ⑨ Test Audiences evaluated Nine ISGE Learning Features using a questionnaire

of 101 Questions

- ⑨ **Ordinal scale of 1 to 7**
 - where, 1= lowest, 7= highest; uses natural adject superlatives
- ⑨ **Mean of Student Evaluation Questions was 6.05 meaning ISGE courseware was “much better than” Conventional Science G.E.**
- ⑨ **Mode of Scores was “7” meaning “very much better than” Conventional Sci. G.E. for 62 out of the 101 questions**

72  **ISGE EVALUATION and ASSESSMENT**

- ⑨ **Students ranked both summary questions...**
 - ...“I would recommend this course to a friend”

 - ...”Overall, I would like to see more courses, both science and non-science, that use multimedia modules and this ‘hybrid’ learning methodology”

- ⑨ **.....at a mean of 6.6 out of 7**

73  **ISGE EVALUATION and ASSESSMENT**

- ⑨ **Although there are a small number of “D” and “F” grade, 72% of the class earned “A” and “B” grades consistently over four different offerings, two different campuses, 100 students**

- ⑨ **...Individual faculty scientists stated that they probably could NOT pass the written midterm and final...(probably because of the interdisciplinary nature of the material...**

74  **GRADES EARNED**

75  **CLASS STANDING**

76  **DEMOGRAPHICS**

77  **EVALUATION SURVEY**

78  **ASSESSMENT**

79  **ASSESSMENT**

80  **REVOLUTION IN LEARNING METHODOLOGY**

⑨ **ISGE I-METHODS MATCH ITS I-MESSAGE**

- ⑨ **Production of Multimedia Modules Gives Time for Interdisc. Teams to Improve Integration in Information; True Synthesis**
- ⑨ **Multimedia Modules do the Information Transfer; They Replace Text and Lectures**
- ⑨ **Computerized Mini-Quizzes and Friendly Diagnosis of Learning Achieved; Personal Tutoring**
- ⑨ **Context-Dependent Help Returns Students to Sections to Ensure Self-Mastery**
- ⑨ **Electronic Information Enables Demonstration of Key Links, Connections, and Bridges Much More Easily**

81  **REVOLUTION IN LEARNING METHODOLOGY**

⑨ **ISGE METHODS MATCH ITS MESSAGE**

- ⑨ **A "Multiple Hybrid" Learning Methodology that INTEGRATES in a revolutionary way...**
 - ...A High Technology Component, with...
 - ...Three Human Face-to-Face Components

- ...A Personal Emphasis with Societal Applications
- ...Group Cooperation with Individual Learning
- ...Learning Science with Learning About Life
- ...Combines Several Learning Techniques into Unified T&L

⑨ **Incorporates Superiority of “Hybrid Vigor”**

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**REVOLUTION IN
LEARNING METHODOLOGY**

⑨ **ISGE METHODS MATCH ITS MESSAGE**

⑨ **Our Special “Hybrid” Methodology Gives the Students More Time to Integrate Material Within Their Own Minds & With Other Students**

⑨ **Through Case Studies and Depth Assignments**

- Student Learning Through Discussions and Skill Practice
- Debates Between ISGE Interdisciplinary Faculty & Between Faculty and Off-Campus Experts
- Production of Modules Allows Interdisc. Teams the Time Needed to Integrate the Content; We Follow Very Detailed Performance Specifications for Presentation & Synthesis

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**Summary: REVOLUTION IN
TRANSDISCIPLINARY METHODS**

- ⑨ Faculty Science Specialists Ensure Coverage of Major Topics in Intro Texts & Emerging “Standards” for Each Sci. Discipline
- ⑨ “Evolving” Interdisciplinary “Scripts” Ensure Solid Integration
- ⑨ Team Teaching with a Twist; Prof. as Mentors & Synthesizers
- ⑨ Integrative Themes in Every Module (Breadth)
- ⑨ Specific Case Studies for Each of Seven Sciences per ITheme (Depth)
- ⑨ Interdisciplinary Skill-Training Sessions per ITheme Emphasize Attainment of Practical and Personal Skills
- ⑨ Interdisciplinary Activity-Discussion Sessions per ITheme
- ⑨ Transdisciplinary Laboratories on Each ITheme
- ⑨ Extensive & Quality Use of the Proven Efficacy of Multimedia

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**REVOLUTION IN
RELEVANCE & PRODUCTION**

THIRD OF 3 COMBINED REVOLUTIONS

- ◆ Permeated Throughout with Applications to Society and Students Personal Lives; Numerous Links & Bridges
- ◆ Students Produce a Product for Society While Learning; Not a Sabbatical from Life; A Time of Direct Service; Taxpayers
- ◆ E.g. Liberal Studies, Pre-Service & In-Service Teachers Adapt Integrated Science for K-12 Products; will serve California *Science Framework*; (same themes; see Chapter 2, pp. 26-33)
- ◆ Multimedia Courseware Enables Replication & Dissemination ...Consistent Presentation & Quality; Course-to-Course, Year-to-Year, Campus-to-Campus
- ◆ More Efficiency-Less Cost...to student, to society

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MARKETING