Conceptual diagrams

A tool for effective science communication

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What is a conceptual diagram?

‘Concept’ from Latin ‘conceptus’ (meaning *thought*); something conceived in the mind (Webster’s 3rd Dictionary, 1986)

‘Diagram’ from Greek ‘diagramma’ (meaning *to mark out by lines*); a graphic design that explains rather than represents, a drawing that shows arrangement and relations (Webster’s 3rd Dictionary, 1986)

‘Model’ from Latin ‘modulus’ (meaning *small measure*); an abstract representation of a system or process (Turner, Gardner & O’Neill, 2001)

**Conceptual diagram** = A diagram using symbols that depicts the essential attributes of a system
Why use conceptual diagrams?

- Helps to clarify thinking (words can be ambiguous; an image commits to the message being portrayed)
- Communication (one-way and two-way – idea presentation and idea development)
- Identify gaps / priorities / essential elements
- Develop syntheses (or present synthesis)
Conceptual diagrams provide an interface

**Science**
- Current understanding
- Credibility & support

**Conceptual diagram**

**Community**
- Priorities & environmental values
- Commitment & resources

**Shared vision**
Good conceptual diagrams are used extensively

Z scheme of photosynthesis

Plate tectonics
Darwin used conceptual diagrams to explain his theory of coral reef formation.
Conceptual diagrams use symbols: an ancient technique to depict unequivocal messages

Cave drawing
(Australian aborigines)

Darwin’s conceptual diagram
Symbols (icons) are a key element of conceptual diagrams

- ‘Symbol’ from Greek ‘symbolon’ (token of identity) and Latin ‘symbolum’ (token, sign)
- ‘Icon’ from Greek ‘eikon’ (to resemble); pictorial representation
- A sign that signifies by virtue of sharing a property with what it represents
  - something that stands for or suggests something tangible
  - a visible thing that stands for something invisible or intangible
- Symbols used in mathematics (e.g. $\pi$), chemistry (e.g. $^{210}\text{Pb}$), music (e.g. $\text{©}$) weather (e.g. $\text{_weather}$), religion (e.g. $\text{faith}$), corporations (e.g. $\text{Nike}$), and organizations (e.g. $\text{Apple}$)
- Symbols can be universal; language independent
- Symbols are scalable; size of symbol can represent relative importance (e.g. $\text{large}$ vs. $\text{small}$)
- Symbols can be information-rich: size, shape, color and position of symbols can convey information
Both shape and color of symbols can be important for recognition.
Symbols are an important feature of everyday life

Shape, color, and images used for traffic signs
In conceptual diagrams, as in maps, symbols need to be explained in a legend.

**Map legend**
- Hiking trail
- Steep trail; arrows point uphill
- Overlook
- Horse trail
- Unpaved road
- Group camp; check at park headquarters for availability
- Parking
- Ranger station
- Picnic area
- Wheelchair accessible
- Public campground
- Private campground

**Conceptual diagram legend**

[Diagram with various icons and labels for biological processes, cycles, environment, threats, and physical processes]
Conceptual diagrams can depict processes at different scales...
Conceptual diagrams can be nested
Conceptual diagrams are not...

... cartoons
Conceptual diagrams are not...

... cartoons

... model relationships
Conceptual diagrams are not...

... cartoons

... model relationships

... colored box & arrow diagrams
Conceptual diagrams are not...

... cartoons

... model relationships

... colored box & arrow diagrams

... A REPLACEMENT FOR GOOD, WELL INTERPRETED DATA!
Conceptual diagrams can augment the effective communication of scientific understanding.

Conceptual diagram that needs two pages of explanatory text

Conceptual diagram with stand-alone legend
Literature citations can be added

References

1. Brodie, 1992
2. Heggie 1999
3. McKee et al, 2001
4. Risk et al, 1994
5. Coles 1987
6. Fabricius & Wolanski, 2000
7. Klumpp and McKinnon, 1992
8. Revelante & Gilmartin, 1982
9. Perry & Dennison, 1999
10. Preen, 1995
11. Aragones & Marsh, 2000

Wet season river floods result in pulsed turbidity events influencing catchment to coral reef zones (1, 4).

Macro grazers (dugong and sea turtle) continually disturb river, estuarine, and coastal zones (9, 10, 11).

Extremely low nitrogen and phosphorus control the coral reef zone (2, 3).
Use of conceptual models facilitates hybrid data/diagrams

Figure 19-16. Attenuation of light through water column and through Thalassia testudinum meadow – assuming uniform biomass distribution, measured light at water surface, canopy surface and sediment surface are indicated, as well as water column ($K_d$) and canopy ($K$) attenuation coefficient (Data from Williams 1987).
Various applications of conceptual diagrams

Research

Synthesis

Monitoring

Management
Conceptual diagrams can be incorporated into various publications

Newsletters

Books

Posters
Nutrient inputs to the west Yucatan Peninsula

Queensland ecosystems

Turtle diet and feeding behaviour
- Green turtles mostly herbivorous
- Hatchlings to juveniles omnivorous
- Young adults and adults feed mostly on seagrasses
- But macroalgae, jellyfish, sponges, squid eggs, mollusc eggs, ascidians & other invertebrates have been recorded

Feeding preference of turtles
- Green turtles seem to prefer Halodule
- Less likely to eat Zostera if it is <1mm

Col Limbus & co-workers have observed turtles foraging in mangroves for the past 15 years. At high tide, turtles move into the mangroves feeding on propagules, cotyledons and canopy leaves. Observed in Shoalwater Bay, Moreton Bay, Western Australia & Galapagos Is.
Conceptual diagrams can be produced in real time to synthesize main messages.

Result of one day meeting into seagrass loss in Western Port.
The Ten Commandments of conceptual diagrams...

1. Thou shalt honor thy audience
2. Thou shalt simplify
3. Thou shalt not use garish colors or apply colors inconsistently
4. Thou shalt use legends in thy diagrams
5. Thou shalt not covet a single style
6. Thou shalt not be constrained by geometry
7. Thou shalt use arrows sparingly
8. Thou shalt not be afraid of making new symbols
9. Thou shalt revise and revise and revise …
10. Thou shalt use diagrams for peer and non-peer audiences
Computer technology has revolutionized the way we assemble material.