Evidence –Centered Assessment Design: Using PADI

Session I:
Design Patterns
Introduction to Student Models

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The “Why” of PADI

- Advanced assessment requires coordination of varied expertise
- Assessment design is both science and art
- Capitalize on schemas for recurring structures, patterns, & relationships
  - Explicit validity arguments
  - Accumulated wisdom sharable—not context bound
  - Interoperability of elements & processes (esp. technological settings)
Session I Overview

- Some “Thinking Tools”
  - Assessment as Argument
  - A Layered Approach
- Design Patterns
- Background on Design Patterns
  - Examples
  - Hands-on: Create a Design Pattern
- Starting into Templates
  - Discussion: Defining Student Model(s) and Student Model Variables
Assessment as Argument

- **Inferences**
- **Observations** needed to ground them
- **Situations** that will evoke them
- Chain of **reasoning** connecting them
A Layered Approach

- Leverage varied expertise
- Common structures
- We’ll use layers to
  - iterate through the assessment argument,
  - using different knowledge representations,
  - moving from knowledge about the domain to the nuts and bolts of assessment design and delivery.
Evidence-Centered Design Layers

- **Domain Analysis**
  - Thinking about e.g., science learning & inquiry

- **Domain Modeling**
  - Express content as an assessment argument

- **Conceptual Assessment Framework**
  - Technical elements of assessment design & delivery

- **Assessment Implementation**

- **Assessment Delivery**
PADI uses **Design Patterns** to organize information in the Domain Modeling layer.

- **Narrative**, not technical, contents
- The Design Pattern schema reflects assessment argument structure.

Express content as an assessment argument.
We Live in a World of Patterns

- Architecture blueprints
- DNA in animals
- Instructions for building furniture
- Cooking Recipes
- Musical scores
- Weather patterns
Analogues

- Design Patterns in Architecture
- Design Patterns in Software Engineering
- Polti’s *Thirty-Six Dramatic Situations*
Identify in narrative form:

- Knowledge, skills, and abilities
- Observations to support inference
- Features of task situations that elicit target KSAs
- Related content or inquiry standards

Do not provide a concrete design or implementation of an assessment task
<table>
<thead>
<tr>
<th><strong>ATTRIBUTE</strong></th>
<th><strong>DESCRIPTION</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rationale</td>
<td>How/why this DP provides evidence about focal knowledge/skill/abilities (KSAs).</td>
</tr>
<tr>
<td>Focal Knowledge, Skills and Abilities</td>
<td>The primary knowledge/skill/abilities targeted by this design pattern.</td>
</tr>
<tr>
<td>Additional KSAs</td>
<td>Other knowledge/skills/abilities that may be required by tasks under this design pattern.</td>
</tr>
<tr>
<td>Potential work products</td>
<td>What students actually say, do, or make, in which they might produce evidence about KSAs.</td>
</tr>
<tr>
<td>Potential observations</td>
<td>Aspects of work products that we want to identify and evaluate, as evidence about students’ KSAs.</td>
</tr>
<tr>
<td>Potential rubrics</td>
<td>Ways of evaluating work products to produce values of observations (rubrics, algorithms, scoring rules).</td>
</tr>
<tr>
<td>Characteristic features of tasks</td>
<td>Aspects of assessment situations that are needed to evoke the desired evidence.</td>
</tr>
<tr>
<td>Variable features of tasks</td>
<td>Aspects of assessment situations that can be varied in order to shift difficulty or focus.</td>
</tr>
</tbody>
</table>
Design Pattern Benefits

- Facilitate decision-making
- Explicate the assessment argument
- Afford flexibility
  - Psychological perspectives
  - Generality
  - Interdependence (i.e., related patterns)
  - Scale
# Design Pattern: Observational Investigations


<table>
<thead>
<tr>
<th>Title</th>
<th>Observational Investigations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overview</strong></td>
<td>This design pattern supports the writing of storyboards and items that address scientific reasoning and process skills in the context of observational (non-experimental) investigations. This design pattern can be used in conjunction with any science content strand. (<a href="http://www.education.umd.edu/EDMS/misley/DRK12/DP1.links.htm">rationale</a>)</td>
</tr>
<tr>
<td><strong>Use (Rationale)</strong></td>
<td>This design pattern should be used to inform the writing of storyboards and items that exhibit the KSAs, either in the context of student investigations or scientist investigations. Use of this design pattern will result in the creation of a storyboard that is set in the context of an observational investigation and permit the development of items that address requisite and related KSAs. (<a href="http://www.education.umd.edu/EDMS/misley/DRK12/DP1.links.htm">use in the classroom</a>)</td>
</tr>
</tbody>
</table>
| **Focal KSAs** | - Storyboards and items written using this design pattern should elicit the following student KSAs:  
  - Understanding why some scientific ideas need to be investigated through observational methods ([detail](http://www.education.umd.edu/EDMS/misley/DRK12/DP1.links.htm))  
  - Ability to analyze situations in which observational methods are more appropriate than experimental methods ([detail](http://www.education.umd.edu/EDMS/misley/DRK12/DP1.links.htm))  
  - Ability to distinguish between observational and experimental methodology ([detail](http://www.education.umd.edu/EDMS/misley/DRK12/DP1.links.htm))  
  - Hypothesis generation or evaluation about scientific phenomena that are subject only to observational testing and not to experimental testing ([detail](http://www.education.umd.edu/EDMS/misley/DRK12/DP1.links.htm))  
  - Appropriate hypothesis testing through observational methods ([detail](http://www.education.umd.edu/EDMS/misley/DRK12/DP1.links.htm))  
  - Observational data collection and analysis ([detail](http://www.education.umd.edu/EDMS/misley/DRK12/DP1.links.htm))  
  - Ability to formulate conclusions, create models, and appropriately generalize results from observational, non-experimental research ([detail](http://www.education.umd.edu/EDMS/misley/DRK12/DP1.links.htm)) |
| **Additional KSAs** | Storyboards and items written using this design pattern may require KSAs that students should have gained in prior grades before they entered the grades that are covered on this test ([Grade 5 benchmarks](http://www.education.umd.edu/EDMS/misley/DRK12/DP1.links.htm))  
  Content knowledge ([potential content areas](http://www.education.umd.edu/EDMS/misley/DRK12/DP1.links.htm)) |
Design Pattern: Observational Investigations

www.education.umd.edu/EDMS/mislevy/DRK12/DP1.links.htm
(cont’d)

<table>
<thead>
<tr>
<th>Title</th>
<th>Observational Investigations</th>
</tr>
</thead>
</table>
| **Characteristic Features** | Storyboards and items written using this design pattern will exhibit one or more of the following features:  
  ▪ Collection, presentation, and or representation of observational data ([example](#))  
  ▪ Analysis and explanation of data; conclusion generation given observational data ([example](#))  
  ▪ Hypothesis generation, explanation, and/or modeling ([example](#))  
  ▪ Model development, analysis, and testing ([example](#))  |
| **Variable Features**      | The following features are variable depending on the storyboard and items:  
  ▪ Content (strand) context ([examples](#))  
  ▪ Qualitative or quantitative investigations ([example](#))  
  ▪ Number of variables and complexity of their interrelationships ([detail](#)) ([example](#))  
  ▪ Simple or complex investigations ([detail](#))  
  ▪ Data representation ([detail](#)) ([example](#))  |
| **Supported Benchmarks**   | Storyboards and items written using this design pattern will most likely address one or more of the following benchmarks.  
  ▪ Grade 5: 3.I.A.1, 5.I.A.1, 3.I.B.1, 3.I.B.2, 3.I.B.3, 4.I.B.1, 4.I.B.3 ([text](#))  
Design and conduct an experiment | Design Pattern 991

Title: Design and conduct an experiment

Summary: Students are asked to design and conduct an experiment to answer a given question. Design involves correctly identifying treatment and control conditions, and the outcome variable, carrying out a set of procedures, interpreting data, formulating answer to question.

Focal Knowledge, Skills, and Abilities
- FK1. Control of variables.
- FK2. Interpretation of data.

Rationale
- R1. Science experiments are defined as those in which the primary purpose is to identify cause-effect relationships.

Additional Knowledge, Skills, and Abilities
- AK1. Ability to carry out procedures (e.g., monitoring, contamination).

Potential observations
- Po1. Legitimacy of procedures.
- Po2. Appropriateness of variables.
- Po3. Consistency between data and interpretation.

Potential work products
- Pw1. Written description of design, outcomes, interpretation.
Scientific Question: If a rainstorm washed fertilizer into the pond, what would happen to the algae in the pond system after one month? Why do you think the fertilizer would affect the algae this way?

Claim: (choose one)
The algae in the pond will decrease.
The algae in the pond will increase.

Reasoning:

Evidence:
Formulating scientific explanations from evidence | Design Pattern 91

<table>
<thead>
<tr>
<th>Title: Formulating scientific explanations from evidence</th>
</tr>
</thead>
</table>

**Summary**

In this design pattern, a student develops a scientific explanation using evidence. The student must make a relevant claim, justify the claim using evidence and scientific reasoning.

A scientific explanation consists of stating a claim, using the data or evidence appropriately to support this claim, and using scientific principles as reasoning to tie the evidence to the claim. A scientific explanation is different from other explanations because it requires using relevant evidence and scientific reasoning.

**Focal Knowledge, Skills, and Abilities**

FK1. The ability to develop scientific explanations using evidence.

Scientific explanations consist of a claim statement, the use of relevant evidence, and reasoning to tie the claim and evidence together.

**Rationale**

R1. Two key aspects of scientific inquiry are the ability to understand scientific phenomena and the ability to be able to propose explanations using evidence. This design pattern addresses both of these.

The National Research Council lays out five essential features of classroom inquiry. Four of the five aspects involve students using evidence to create and justify explanations.

**Additional Knowledge, Skills, and Abilities**

AK1. Knowledge of appropriate content

AK2. Formulating a logical claim based on the given data or evidence

AK3. View the situation from a scientific perspective

AK4. Weighing, sorting, interpreting data/evidence

**Potential observations**

Po1. The claim reflects an understanding of the data given and relevant scientific knowledge

Po2. The data that are used to support the claim are relevant, the more pieces of relevant data used, the better

Po3. There should be logical consistency between the evidence and the claim

Po4. The reasoning uses appropriate scientific principles to link the evidence to the claim

**Potential work products**

Pw1. Multiple Choice - matching claim statement and evidence

Pw2. Scaffolded written response -- students prompted to formulate a claim, choose evidence, and provide reasoning

Pw3. Un scaffolded written response - creation of claim statement, use of appropriate evidence to justify claim, and explicit use of reasoning to link the evidence to the claim.

Pw4. Spoken explanation when in a situation involving scientific concepts

When using think-alouds, classroom observations, or interviews
### Potential rubrics

- **Pr1. Claim (2 total points)**
  - Full (2): complete sentence that includes all important elements
  - Partial (1): claim with missing elements but with minimum required element
  - Incorrect (0): No claim statement, incomplete or incorrect claim

- **Pr2. Evidence (2 total points)**
  - Full (2): Gives 2 relevant pieces of evidence
  - Partial (1): Gives 1 piece of relevant evidence
  - Incomplete (0): Irrelevant or no evidence

- **Pr3. Reasoning (1 total point)**
  - Full (1): Tie evidence to claim with a reasoning statement that uses scientific principles
  - Incomplete (0): No reasoning or incorrect / irrelevant reasoning given

### Characteristic features

- **CF1. Students provided with context or scenario**
- **CF2. Students use scientific principles to choose or create an explanation based on the scenario**

### Variable features

- **V1. Amount of data provided**
  - The amount of data provided can make the question easier or harder. If more irrelevant information is provided, students will have to be better at sorting to find the appropriate evidence to use. However, if more relevant information is provided, finding evidence to support a claim will be easier.

- **V2. Difficulty of the problem context/content**
  - The level of the question can be varied by the amount of context the student needs to bring to the question as well as the amount of interpretation of the evidence is necessary.

- **V3. Level of prompting/scaffolding of inquiry skill (explanation formation)**
  - Less prompting makes the item more difficult for the student and thus gives better evidence about whether a student is able to create scientific explanations using data on their own. More prompting makes the item easier and thus gives evidence about whether a student is able to provide an explanation using data when given the appropriate format in which to do so.

### I am a kind of

- Analyze data relationships. A student encounters two or more sets of data organized into one or more representations, and must d...

- Generate explanations based on underlying scientific principles. Students are asked questions about scientific phenomena that require them to explain what they know...

- Interpret data. Students are presented with a set of data or observations and are asked to formulate an explanation ...

- Use data to support scientific argument. A student must use data, either collected or provided, to support a scientific argument. Does the s...

### Educational standards

- **NSES BASI1.4. Develop descriptions, explanations, predictions, and models using evidence. Students should base the...**
Mid-Flight Check

So far so good?
Thinking about science learning & inquiry

Express content as an assessment argument

Technical elements of assessment design & delivery

Domain Analysis

Domain Modeling

Conceptual Assessment Framework

Assessment Implementation

Assessment Delivery
PADI Task Templates

- Support the specification of technical details
- Serve as **pre-blueprints**: abstractions of multiple assessment tasks
- Become task specifications when all template components are specified

Diagram:
- Conceptual Assessment Framework
- Assessment Implementation
- Assessment Delivery

Technical elements of assessment design & delivery
Aspects of assessment situations that can be varied in order to shift difficulty or focus.

**Variable features**
Aspects of assessment situations that are needed to evoke the desired evidence.

**Characteristic features**
Modes, like a written product or a spoken answer, in which students might produce evidence about KSAs.

**Potential work products**
Aspects of work products that we want to identify and evaluate, as evidence about students' KSAs.

**Potential observations**
Ways of evaluating work products to produce values of observations.

**Potential rubrics**
The primary knowledge/skill/abilities targeted by this design pattern.

**Focal Knowledge, Skills and Abilities**
How/why this DP provides evidence about focal knowledge/skill/abilities (KSAs).

**Rationale**

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**Domain Modeling**

**Conceptual Assessment Framework**
Aspects of assessment situations that can be varied in order to shift difficulty or focus.

Variable features

Aspects of assessment situations that are needed to evoke the desired evidence.

Characteristic features

Modes, like a written product or a spoken answer, in which students might produce evidence about KSAs.

Potential work products

Some possible things one could see students doing that would give evidence about the KSAs.

Potential observations

Other knowledge/skills/abilities that may be required by tasks under this design pattern.

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How/why this DP provides evidence about focal knowledge/skill/abilities (KSAs).

Rationale

Claim, alternatives

Domain Modeling

Student Model

SM Vars

Conceptual Assessment Framework

TEMPLATE

ATTRIBUTE

Rationale

Focal Knowledge, Skills and Abilities

Potential rubrics

Potential observations

Potential work products

Characteristic features

Variable features
### Data re situation

Aspects of assessment situations that can be varied in order to shift difficulty or focus.

### Variable features

Data re situation

Aspects of assessment situations that are needed to evoke the desired evidence.

### Characteristic features

Data re performance

Modes, like a written product or a spoken answer, in which students might produce evidence about KSAs.

### Potential work products

Data re performance

Some possible things one could see students doing that would give evidence about the KSAs.

### Potential observations

Claim, alternatives

Other knowledge/skills/abilities that may be required by tasks under this design pattern.

### Potential rubrics

Claim

The primary knowledge/skill/abilities targeted by this design pattern.

### Focal Knowledge, Skills and Abilities

Rationale

How/why this DP provides evidence about focal knowledge/skill/abilities (KSAs).

### Domain Modeling

#### Attribute

<table>
<thead>
<tr>
<th>Rationale</th>
<th>Focal Knowledge, Skills and Abilities</th>
<th>Potential rubrics</th>
<th>Potential observations</th>
<th>Potential work products</th>
<th>Characteristic features</th>
<th>Variable features</th>
</tr>
</thead>
</table>

#### Conceptual Assessment Framework

**TEMPLATE**

**Activity**

- **Student Model**
  - SM Vars
## Domain Modeling

### Conceptual Assessment Framework

#### ATTRIBUTE

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<tr>
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<th>Potential observations</th>
<th>Potential work products</th>
<th>Characteristic features</th>
<th>Variable features</th>
</tr>
</thead>
</table>

#### TEMPLATE

- **Student Model**: SM Vars

#### Activity

- **Work Products**: Materials & Presentation
Data re situation

Aspects of assessment situations that can be varied in order to shift difficulty or focus.

Variable features

Data re situation

Aspects of assessment situations that are needed to evoke the desired evidence.

Characteristic features

Modes, like a written product or a spoken answer, in which students might produce evidence about KSAs.

Potential work products

Some possible things one could see students doing that would give evidence about the KSAs.

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Other knowledge/skills/abilities that may be required by tasks under this design pattern.

Potential rubrics

The primary knowledge/skill/abilities targeted by this design pattern.

Focal Knowledge, Skills and Abilities

Rationale

Claim, alternatives

Warrant

Rationale

Toulmin

DESCRIPTION

ATTRIBUTE

Template

Student Model

Evaluation Procedures

Work Products

Materials & Presentation

Domain Modeling

Conceptual Assessment Framework

Activity

SM Vars

Obs Vars

Evaluation Phases

SM Vars Obs

Vars Obs

Evaluation Phases

Work Products

Materials & Presentation

Domain Modeling Conceptual Assessment Framework
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**Characteristic features**

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**Potential work products**

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**Potential observations**

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**Potential rubrics**

The primary knowledge/skill/abilities targeted by this design pattern.

**Focal Knowledge, Skills and Abilities**

How/why this DP provides evidence about focal knowledge/skill/abilities (KSAs).

**Rationale**

Other knowledge/skills/abilities that may be required by tasks under this design pattern.

**Claim**

The primary knowledge/skill/abilities targeted by this design pattern.

**Alternatives**

How/why this DP provides evidence about focal knowledge/skill/abilities (KSAs).

**Warrant**

Other knowledge/skills/abilities that may be required by tasks under this design pattern.

**Toulmin**

How/why this DP provides evidence about focal knowledge/skill/abilities (KSAs).

**Domain Modeling Conceptual Assessment Framework**

**ATTRIBUTE**

- Rationale
- Focal Knowledge, Skills and Abilities
- Potential rubrics
- Potential observations
- Potential work products
- Characteristic features
- Variable features

**TEMPLATE**

**Activity**

- Student Model
- SM Vars
- Evaluation Procedures
- Measurement Models
- Obs Vars
- Evaluation Phases
- Work Products
- Materials & Presentation

**Domain Modeling**

**Conceptual Assessment Framework**
Aspects of assessment situations that can be varied in order to shift difficulty or focus.

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Potential rubrics

The primary knowledge/skills/abilities targeted by this design pattern.

Claim, alternatives

How/why this DP provides evidence about focal knowledge/skill/abilities (KSAs).

Warrant
Viewing Student Models

For starters:

- BioKIDS Main Template (#2497)
# BioKIDS Main Template | Template 2497

**Title:** BioKIDS Main Template

**Summary:**

The BioKIDS assessment contains activities that require students to utilize multiple aspects of knowledge and skills including: content knowledge, ability to formulate a scientific explanation, and the ability to interpret data.

**Type:** [Add]

**Student Model Summary:**

- **SM1:** The student models in the BioKIDS assessments can include multiple aspects of content knowledge as well as multiple aspects of scientific inquiry reasoning.

- **SM2:** The science content areas include: classification, ecology and biodiversity.

- **SM3:** Inquiry reasoning: Interpreting data, formulating scientific explanations, and making hypotheses and predictions.

**Student Models**

- **Biokids 5-Dimension Content Knowledge and Biodiversity**
- **Biokids 5-Dimension Content Knowledge and Inquiry Reasoning**
- **Biokids 5-Dimension Content Knowledge and Hypothesis/Declaration**
- **Biokids 5-Dimension Content Knowledge and Combined Inquiry**

**Measurement Model Summary:**

- **MM1:** Assessment tasks (or activities) have measurement models which vary. Some are dichotomous multiple-choice models, others are bundles with both MC and open-ended models.

**Evaluation Procedures Summary:**

- **EP1:** Multiple choice items are dichotomous (0=incorrect; 1=correct). Open ended items are scored on a partial credit model (usually a 0-1-2 scale). Bundles are indicated where several student work products are dependent on the other.

**Work Product Summary:**

- **IP1:** Some multiple choice (4-5 options)

**Task Model Variable Summary:**

- **TM1:** At the assessment level, the task model variables are not yet set, but at the activity level, we can set values for the TMVs.
<table>
<thead>
<tr>
<th>Template-level Task Variables</th>
<th>Administration Type</th>
<th>Task may be administered via computer or via paper and pencil. Content area. Specific domain content under consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task Model Variable Settings</td>
<td>[ Idea ]</td>
<td></td>
</tr>
<tr>
<td>Materials and Presentation Requirements</td>
<td>Ma1. Students are given a paper assessment and they must have something to write with</td>
<td></td>
</tr>
<tr>
<td>Template-level Materials and Presentation</td>
<td>[ Idea ]</td>
<td></td>
</tr>
<tr>
<td>Materials and Presentation Settings</td>
<td>[ Idea ]</td>
<td></td>
</tr>
<tr>
<td>Activities Summary</td>
<td>A51. Students are presented with several contexts, data, and/or representations and are asked to interpret data and build explanations in the given contexts.</td>
<td></td>
</tr>
<tr>
<td>Activities</td>
<td>Step 1. Simple task. In this type of task, students are presented with a scenario, given data/evidence and they must choose...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Step 2. Moderate open ended written response. Requires the formation of a scientific explanation (Claim + Evidence) - but has scaffolding for the...</td>
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</tr>
<tr>
<td></td>
<td>Step 3. Complex open ended written response. Students are presented with an unscaffolded question and they must formulate an answer using the inf...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Step 3. Complex Performance task. Students must manipulate one/some tool(s) of science or data in order to answer the question.</td>
<td></td>
</tr>
<tr>
<td>Tools for Examinee</td>
<td>TF1. Written assessment with contextual scenarios, data, and activities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TF2. Writing implement</td>
<td></td>
</tr>
<tr>
<td>Exemplars</td>
<td></td>
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</tr>
<tr>
<td>Educational Standards</td>
<td>NSES BASI1.3 Use appropriate tools and techniques to gather, analyze, and interpret data. The use of tools and technique...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NSES BASI1.4 Develop descriptions, explanations, predictions, and models using evidence. Students should base teh...</td>
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<tr>
<td></td>
<td>NSES BASI1.5 Think critically and logically to make the relationships between evidence and explanations. Thinking...</td>
<td></td>
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<tr>
<td></td>
<td>NSES BASI1.6 Recognize and analyze alternative explanations and predictions. Students should develop the ability...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NSES BASI2.5 Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific...</td>
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</tbody>
</table>
# BioKIDS 5 Dimensions

## BioKIDS 5-Dimension | Student Model 1052

<table>
<thead>
<tr>
<th>Title:</th>
<th>BioKIDS 5-Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary</td>
<td>Content knowledge: Biodiversity</td>
</tr>
<tr>
<td></td>
<td>Inquiry Reasoning: Making predictions and hypotheses; Formulating scientific explanations; Reexpressing data; Interpreting data</td>
</tr>
<tr>
<td>Distribution Summary</td>
<td>DTI: Multivariate normal</td>
</tr>
<tr>
<td>Distribution Type</td>
<td>DTI: Multivariate normal</td>
</tr>
<tr>
<td>Student Model Variables</td>
<td>Biodiversity context: Student examines concepts related to animal abundance, richness and the combination of the two in the...</td>
</tr>
<tr>
<td></td>
<td>Building Explanation from Evidence: BioKIDS Inquiry Skill</td>
</tr>
<tr>
<td></td>
<td>Creating Hypotheses and Predictions: Students understand and can create scientific hypotheses and predictions</td>
</tr>
<tr>
<td></td>
<td>Data Interpretation: Students are able to use data to solve a problem or develop an explanation; Reexpressing data: Students can use different kinds of methods to express data</td>
</tr>
<tr>
<td>Covariance Matrix</td>
<td>[View] (Modified 2004-01-29)</td>
</tr>
<tr>
<td>Means Matrix</td>
<td>[View]</td>
</tr>
</tbody>
</table>

### Means Matrix

| I am a kind of |  |
| These are kinds of me |  |
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### Online resources

- BioKIDS Multimedia, (Template #1076)
- BioKIDS Main Template, (Template #2047)
- Building Explanations BioKIDS, (Student Model #132)
- Formulating Explanations From Evidence - all levels, (Template #169)
BioKIDS 4 Dimensions

Title: BioKIDS-4dim (content + 3inquiry)

Summary
SMV1: biodiversity content
SMV2: Explanations
SMV3: Interpreting Data
SMV4: Hypotheses and Predictions

Distribution Summary

Distribution Type

Student Model Variables

Covariance Matrix

Means Matrix

I am a kind of

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Online resources

References

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BioKIDS Main Template (Template #2497)
BioKIDS Explanations (Template #245)
Formulating Explanations From Evidence - all levels (Template #149)
### BioKIDS: two-dim (Content and Inquiry) | Student Model 996

#### Title
**EDIT** Biodiversity Content and Combined Inquiry (combines four inquiry skills: Hypothesis/Prediction, Explanation, Interpreting data and Re-express data)

#### Summary
**EDIT**
Biodiversity Content and Combined Inquiry (combines four inquiry skills: Hypothesis/Prediction, Explanation, Interpreting data and Re-express data)

#### Distribution Summary
- **EDIT** DS1: Bivariate normal distribution

#### Distribution Type
**EDIT** DT1: Multivariate normal

#### Bivariate normal distribution

#### Student Model Variables
- **EDIT**
  - **Biological Inquiry**: Combined inquiry skills: Hypothesis/Prediction, Explanation, Interpreting data and Re-express data
  - **Biodiversity content**: Student examines concepts related to animal abundance, richness and the combination of the two in the...

#### Covariance Matrix
**EDIT**

#### Means Matrix
**EDIT**

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#### Online resources
**EDIT**

#### References
**EDIT**

#### I am a part of
- BioKIDS - multiDimTwo. (Template #335)
- BioKIDS Main Template. (Template #2497)
- Formulating Explanations BioKIDS. (Student Model #345)
- Formulating Explanations From Evidence - all levels. (Template #1475)
PADI Student Models from FOSS (ASK) Main Template
PADI Student Model

FOSS (ASK) 9 Dimensions

Title: ASK 9-MD Inquiry (for Diagnostics) | Student Model 1489

Summary: This version of the SM includes more levels on each Key Concept to provide more detailed formative assessment information. Students can engage questions to guide investigation. They design, plan and conduct investigations and experiments to answer questions. They acquire and interpret data to draw conclusions and construct explanations, engaging in language, mathematics, and graphics to communicate scientific knowledge.

Key Concepts Include:
- ASK Plan Investigations (SMV 1239)
- Ask Gather and Organize Data (SMV 1240)
- ASK Interpret Data and Construct Explanations (SMV 1665)

Student Model Variables:
- ASK 9-MD Inquiry for Diagnostics
- ASK Explanations Supported by Evidence (IN3-Construct)
- ASK Interpret Data (IN3-Construct)
- ASK Lab Practices (IN2-Construct)
- ASK Observations and Measurements (IN2-Construct)
- ASK Organizing Data (IN2-Construct)
- ASK Predictions Based on Prior Knowledge (IN1-Construct)
- ASK Predictions From Data (IN3-Construct)
- ASK Procedures and Variables (IN1-Construct)
- ASK Questions (IN1-Construct)

Covariance Matrix

Means Matrix

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### FOSS (ASK) 3 Dimensions

#### Title
ASK 3-MD Inquiry

#### Summary
Students can engage questions to guide investigation. They design, plan and conduct investigations and experiments to answer questions. They acquire and interpret data to draw conclusions and construct explanations, engaging in language, mathematics, and graphics to communicate scientific knowledge. In addition, students cultivate an internal dialog of questioning that evokes the scientific habits of mind.

#### Distribution Summary
- **DT1. Multivariate normal**

#### Distribution Type
- DT1. Multivariate normal

#### Student Model Variables
- **ASK Gather and Organize Data (M3-Key Concept)**, Students use appropriate tools and techniques to gather and organize data. The use of tools and...  
- **ASK Interpret Data and Construct Explanations (N5-Key Concept)**, Students are able to interpret data (recognize trends and patterns) and base explanations on what th...  
- **ASK Plan Investigations (N5-Key Concept)**, Students develop general abilities to plan investigations. The type of investigation (systematic ob...  

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<tr>
<th>Covariance Matrix</th>
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</tbody>
</table>

#### I am a kind of
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#### Online resources

#### References
- R1. ASK Inquiry Construct Map 1:20:06  
- R2. Larry Malone notes of 11-23-04.

#### I am a part of
#### ASK Exception Scenario Template
PADI Student Model

FOSS (ASK) I Dimension

![Image of a diagram showing the PADI Student Model and FOSS (ASK) I Dimension. The diagram includes sections for Design Patterns, Exemplars, Template, Task Specifications, and student model variables.]

### ASK Unidimensional Inquiry | Student Model 1310

**Title:** ASK Unidimensional Inquiry

**Summary:** Students exhibit KSAs in inquiry including engaging questions to guide investigation; designing, planning, and conducting investigations and experiments to answer questions; acquiring and interpreting data to draw conclusions and construct explanations; engaging in language, mathematics, and graphics to communicate scientific knowledge; and how they have cultivated an internal dialog of questioning that evokes the scientific habits of mind.

**Distribution Summary:**

- **Distribution Type:** Univariate normal

**Student Model Variables:** ASK Inquiry SKY: A unidimensional variable of inquiry knowledge.

- **Covariance Matrix:**

- **Means Matrix:**

- **I am a kind of:**

- **These are kinds of me:**

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**Online resources:**

- **References:**
  - R2. Larry Malone notes of 11-23-04.

**I am a part of:**

- ASK Exception Scenario Template
- ASK Inquiry Assessment
- ASK Model Scenario Template
- ASK New Inquiry Lab Template
- ASK Performance Template
Activity I: Creating a Design Pattern,

- Co-design an assessment using a Design Pattern

Activity II. Defining a Student Model and Student Model Variables

- Define Student Model(s)
- Define Student Model Variable(s)