Evidence –Centered Assessment Design: Using PADI

Session I:
Design Patterns
Introduction to Student Models

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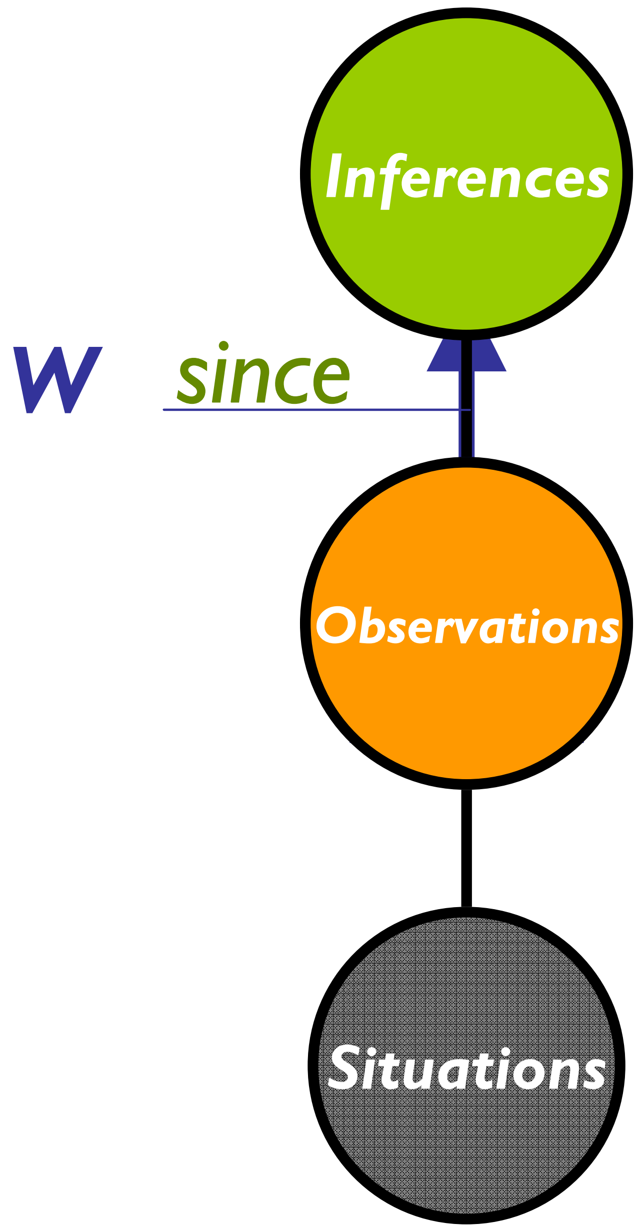
The "Why" of PADI

- 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

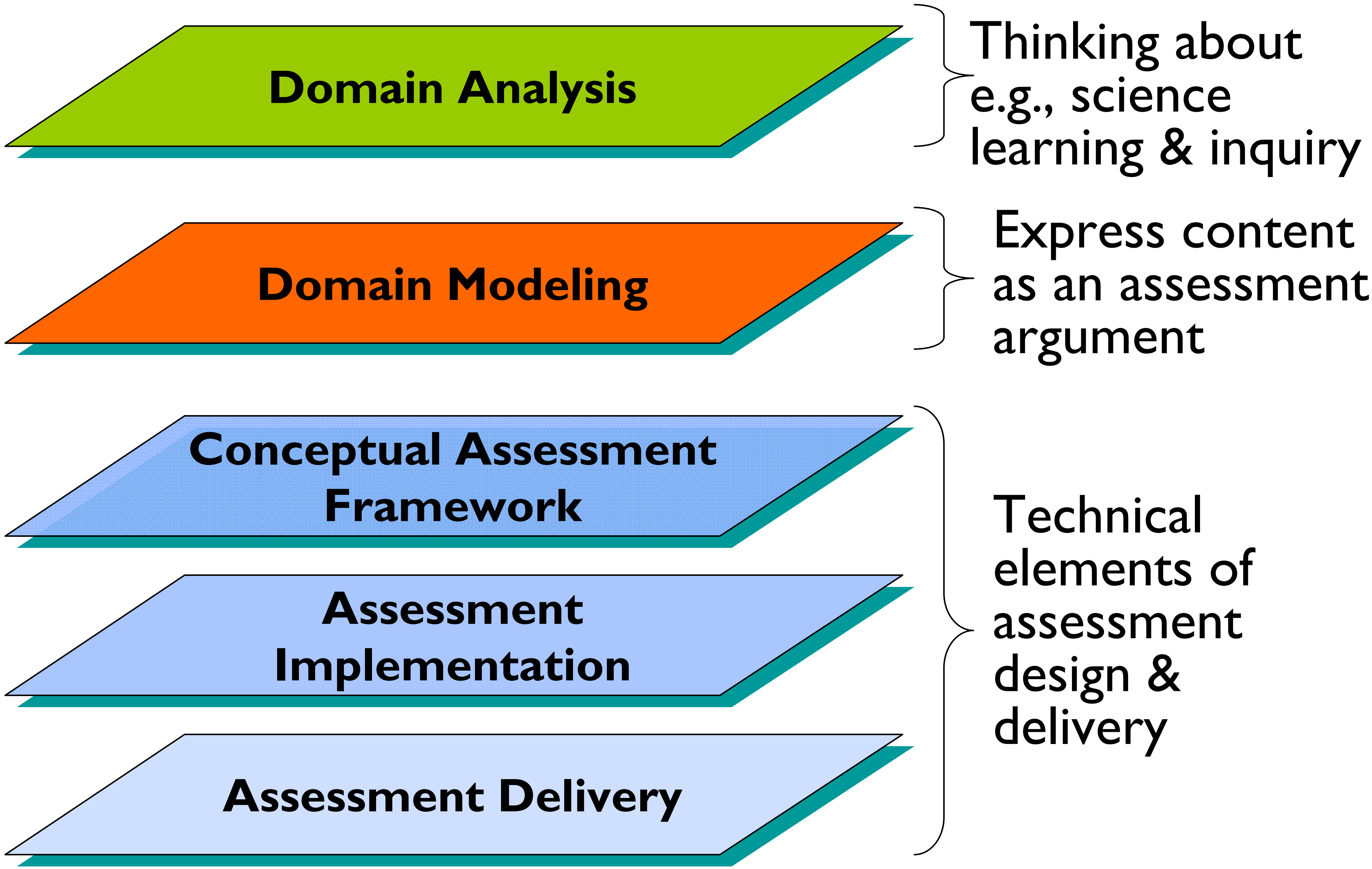


- **Inferences**
- **Observations** needed to ground them
- **Situations** that will evoke them
- Chain of **reasoning** connecting them

A Layered Approach

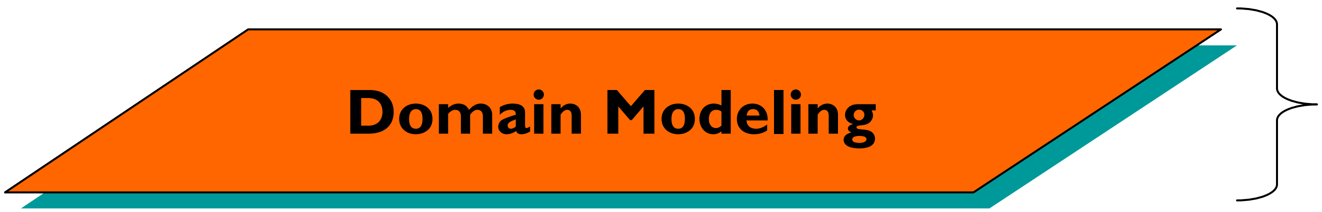
- Leverage varied expertise
- Common structures
- We'll use layers to
  - iterate through the **assessment argument,**
  - using different **knowledge representations**,
  - moving from **knowledge about the domain** to the nuts and bolts of **assessment design and delivery**.

Evidence-Centered Design Layers



Design Patterns

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



Express content as an assessment argument

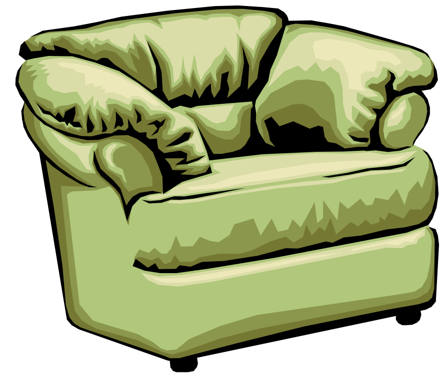
- **Narrative**, not technical, contents
- The Design Pattern schema reflects **assessment argument** structure

We Live in a World of Patterns

Architecture blueprints

DNA in animals

Instructions for building furniture



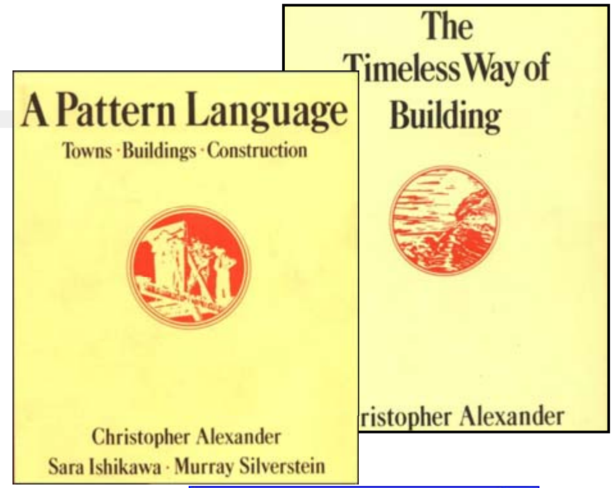
Weather patterns

Cooking Recipes

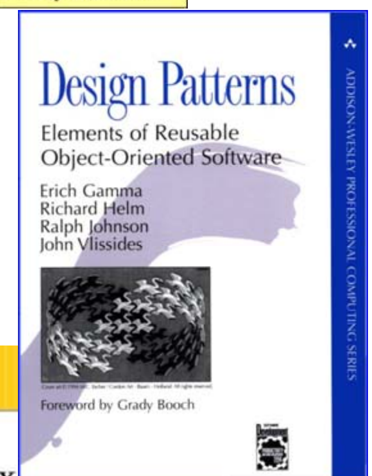
Musical scores

Analogues

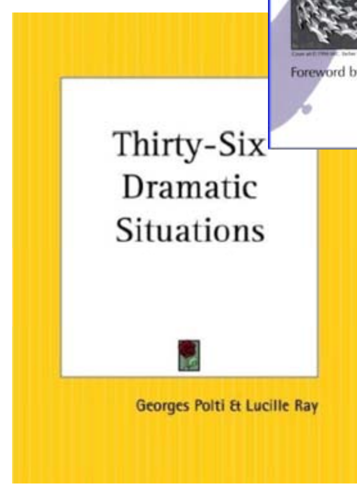
- Design Patterns in Architecture



- Design Patterns in Software Engineering



- Polti's *Thirty-Six Dramatic Situations*



PADI Design Patterns

- 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*

ATTRIBUTE	DESCRIPTION
Rationale	How/why this DP provides evidence about focal knowledge/skill/abilities (KSAs).
Focal Knowledge, Skills and Abilities	The primary knowledge/skill/abilities targeted by this design pattern.
Additional KSAs	Other knowledge/skills/abilities that may be required by tasks under this design pattern.
Potential work products	What students actually say, do, or make, in which they might produce evidence about KSAs.
Potential observations	Aspects of work products that we want to identify and evaluate, as evidence about students' KSAs.
Potential rubrics	Ways of evaluating work products to produce values of observations (rubrics, algorithms, scoring rules).
Characteristic features of tasks	Aspects of assessment situations that are needed to evoke the desired evidence.
Variable features of tasks	Aspects of assessment situations that can be varied in order to shift difficulty or focus.

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

www.education.umd.edu/EDMS/mislevy/DRK12/DP1.links.htm

Title	**Observational Investigations**
Overview	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. (rationale)
Use (Rationale)	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. (use in the classroom)
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) ▪ Ability to analyze situations in which observational methods are more appropriate than experimental methods (detail) ▪ Ability to distinguish between observational and experimental methodology (detail) ▪ Hypothesis generation or evaluation about scientific phenomena that are subject only to observational testing and not to experimental testing (detail) ▪ Appropriate hypothesis testing through observational methods (detail) ▪ Observational data collection and analysis (detail) ▪ Ability to formulate conclusions, create models, and appropriately generalize results from observational, non-experimental research (detail)
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) Content knowledge (potential content areas)

Design Pattern: Observational Investigations

www.education.umd.edu/EDMS/mislevy/DRK12/DP1.links.htm

(cont'd)

Title	Observational Investigations
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) ▪ Grade 8: 6.I.A.2, 7.I.A.2, 6,I.B.1, 7.I.B.1, 6.I.B.2, 6.I.B.4, 8.I.B.1, 8.I.B.2 (text) ▪ High School: 9-12.I.A.3, 9-12.I.B.1, 9-12.I.B.6 (text)

FOSS (ASK) Design Pattern Example

Design Patterns | Education Standards | Exemplars | Templates | Task Specifications | Student Models | Student Model Variables | Activities | Meas. Models | Observable Variables | Eval. Procedures | Evaluation Phases | Work Products | Materials & Presentation | Task Model Variables

Hello klong
Account Settings
Logout
Edit Model

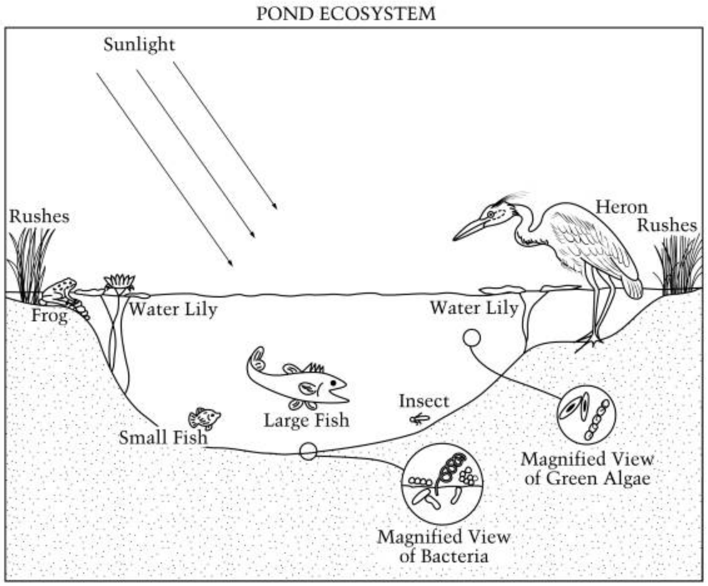
Design and conduct an experiment | Design Pattern 991

[View Tree | Duplicate | Export]

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.	Overview of relevant assessment situations and relation to targeted knowledge, skills, and abilities.
Focal Knowledge, Skills, and Abilities	FK1. Control of variables. FK2. Interpretation of data.	The primary knowledge/skill/abilities targeted by this design pattern are:
Rationale	R1. Science experiments are defined as those in which the primary purpose is to identify cause-effect relationships.	Explicate the chain of reasoning connecting the inference of interest about student proficiency to potential observations and work products.
Additional Knowledge, Skills, and Abilities	AK1. Ability to carry out procedures (e.g., monitoring, contamination).	Other knowledge/skills/abilities that may be required by this design pattern include:
Potential observations	Po1. Legitimacy of procedures. Po2. Appropriateness of variables. Po3. Consistency between data and interpretation.	Some possible things one could see students doing that would give evidence about the KSAs (knowledge/skills/abilities).
Potential work products	Pw1. Written description of design, outcomes, interpretation.	Some possible things one could see students doing that would give evidence about the

Done

A BioKIDS Task



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:

BioKIDS Design Pattern

Design Patterns | Education Standards | Exemplars | Templates | Task Specifications | Student Models | Student Model Variables | Activities | Meas. Models | Observable Variables | Eval. Procedures | Evaluation Phases | Work Products | Materials & Presentation | Task Model Variables

Hello ghaertel
Account Settings
Logout

Edit Model

Formulating scientific explanations from evidence | Design Pattern 91

[View Tree | Duplicate | Export]

Title:	Formulating scientific explanations from evidence	
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. Unscaffolded 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

Done

BioKIDS Design Pattern (cont'd)

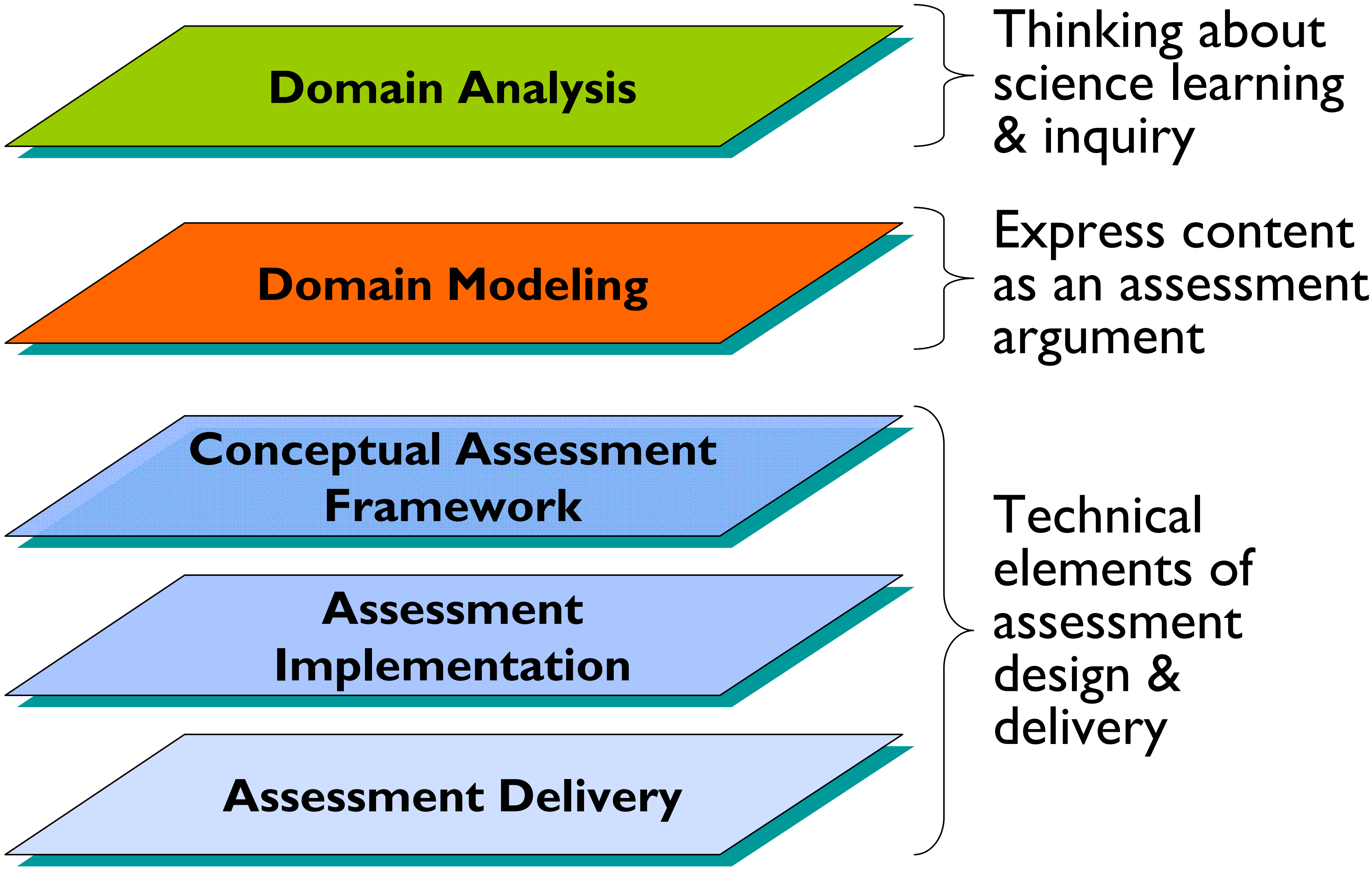
Potential rubrics	Pr1. Claim (2 total points) Full (2): complete sentence that includes all important elements Partial (1): claim with missing elements but with minimum required element Incorrect (0): No claim statement, incomplete or incorrect claim Pr2. Evidence (2 total points) Full (2): Gives 2 relevant pieces of evidence Partial (1): Gives 1 piece of relavant evidence Incomplete (0): Irrelevant or no evidence Pr3. Reasoning: (1 total point) Full (1): Ties 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 a context or scenario Cf2. Students use scientific principles to choose or create an explanation based on the scenario	
Variable features	Vf1. 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.
	Vf2. Difficulty of the problem context/content	The level of the question can be varied by the amount of content the student needs to bring to the question as well as the amount of interpretation of the evidence is necessary.
	Vf3. 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 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		
These are kinds of me		
These are parts of me	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 8ASI1.4. Develop descriptions, explanations, predictions, and models using evidence. Students should base the...	

Done

Mid-Flight Check

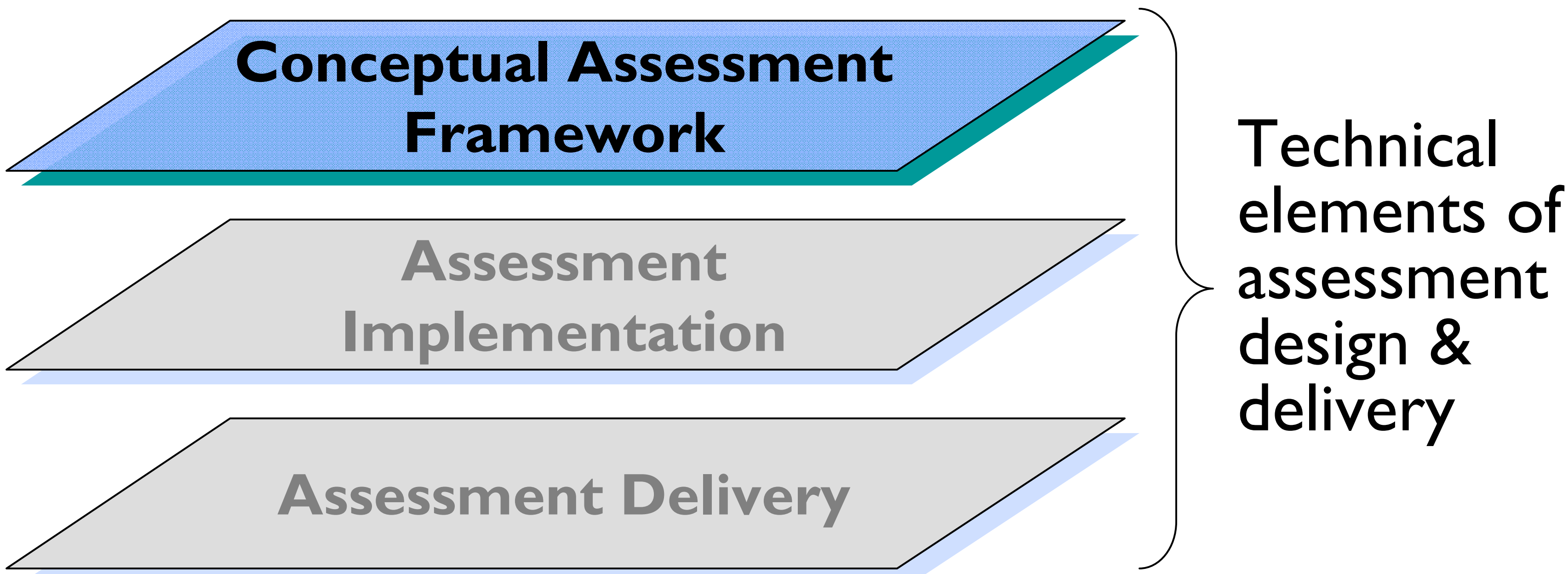
So far so good?

(Back to) ECD Layers



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



Domain Modeling

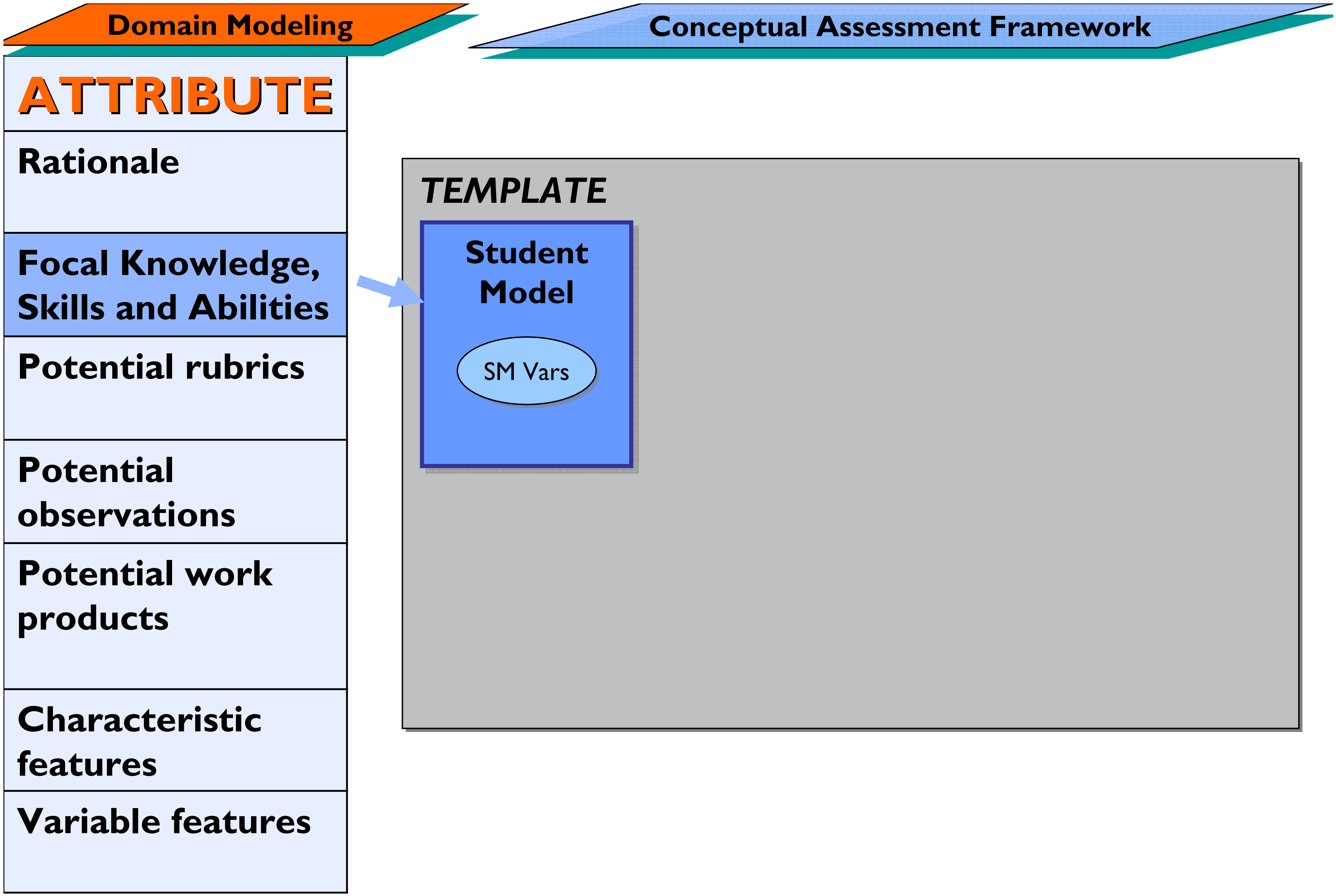
ATTRIBUTE
Rationale
Focal Knowledge, Skills and Abilities
Potential rubrics
Potential observations
Potential work products
Characteristic features
Variable features

Domain Modeling

Conceptual Assessment Framework

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

TEMPLATE


Domain Modeling
Conceptual Assessment Framework
ATTRIBUTE
Rationale
Focal Knowledge, Skills and Abilities
Potential rubrics
Potential observations
Potential work products
Characteristic features
Variable features
TEMPLATE
Student Model
SM Vars

Domain Modeling

Conceptual Assessment Framework

ATTRIBUTE

Rationale

Focal Knowledge, Skills and Abilities

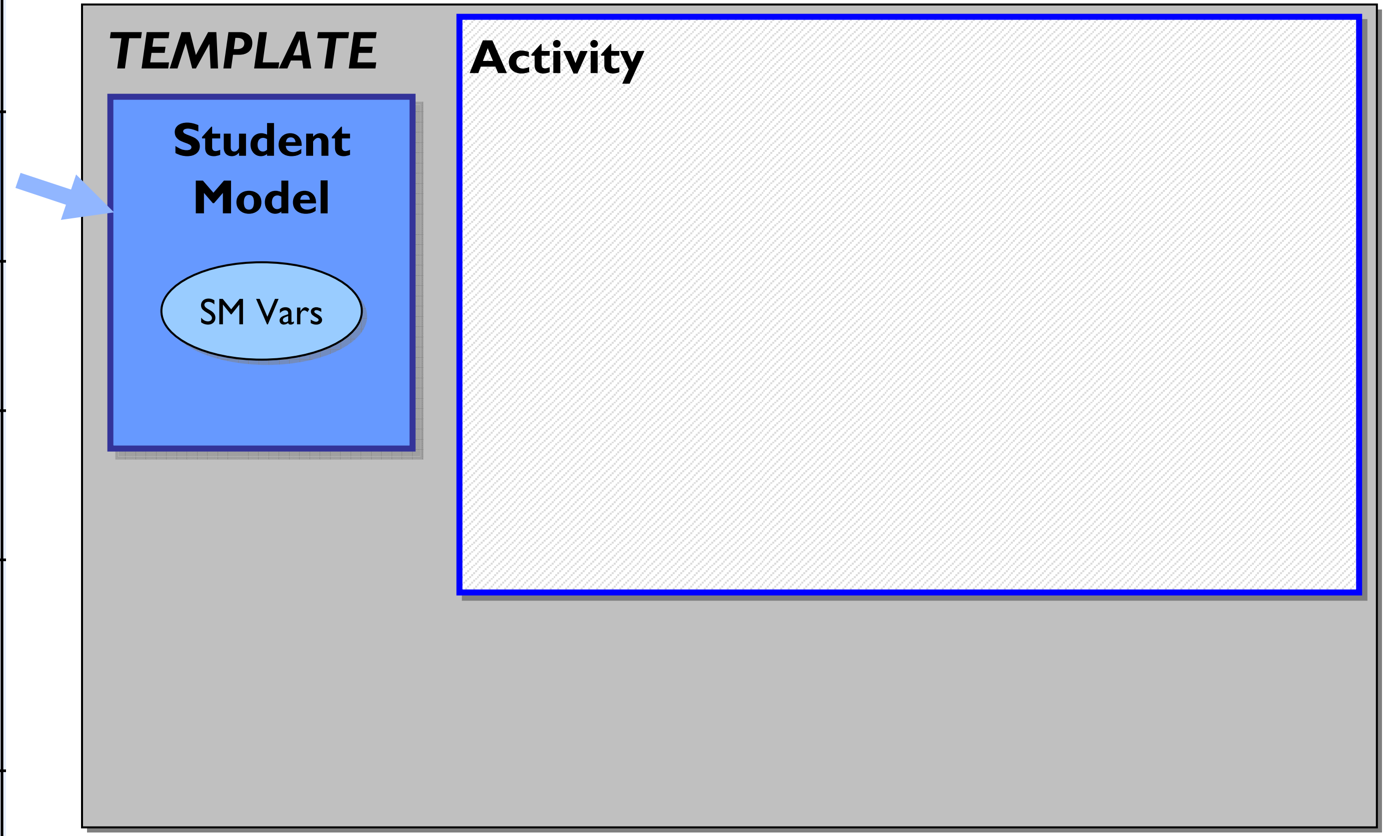
Potential rubrics

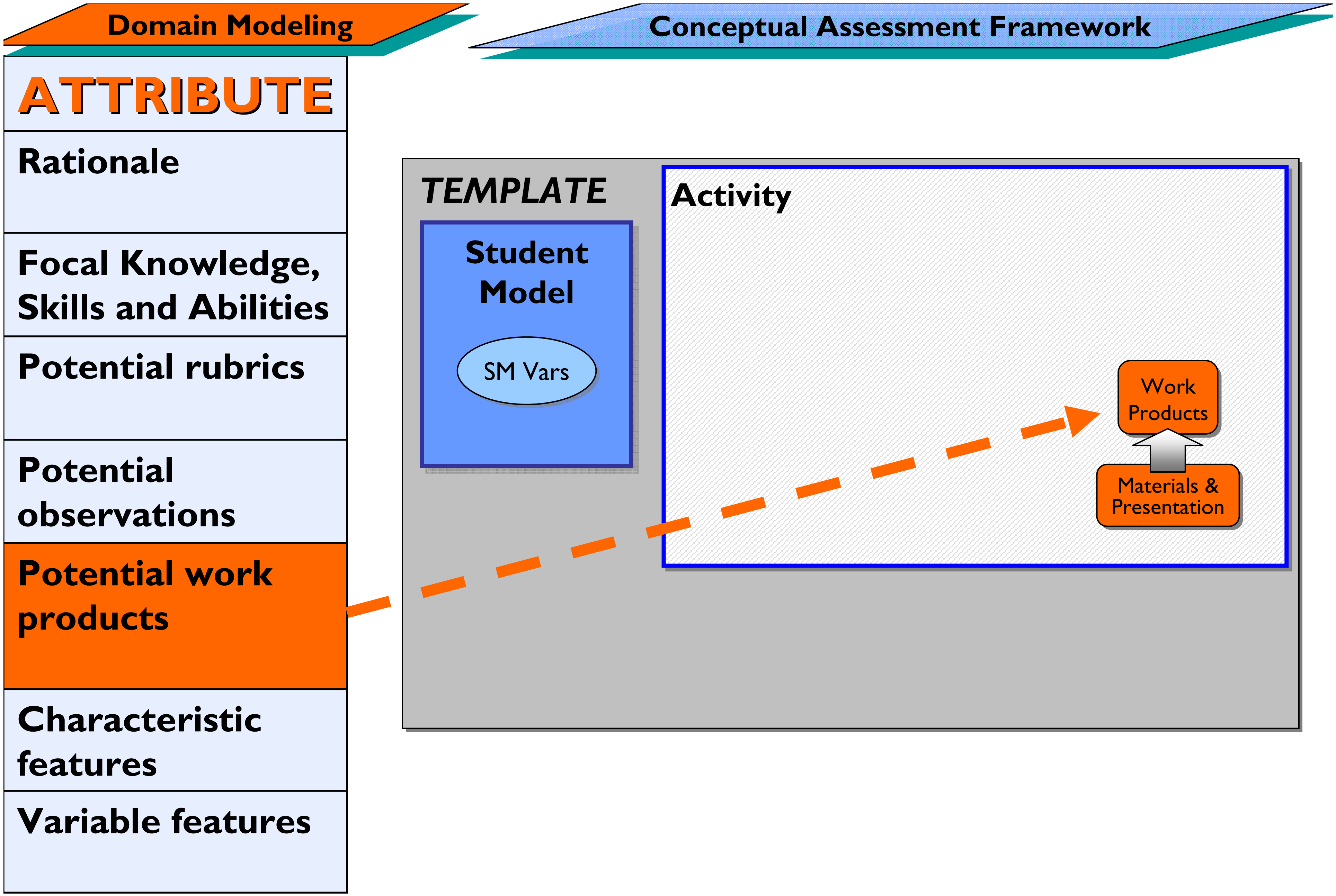
Potential observations

Potential work products

Characteristic features

Variable features





Domain Modeling
Conceptual Assessment Framework
ATTRIBUTE
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Focal Knowledge, Skills and Abilities
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Potential observations
Potential work products
Characteristic features
Variable features
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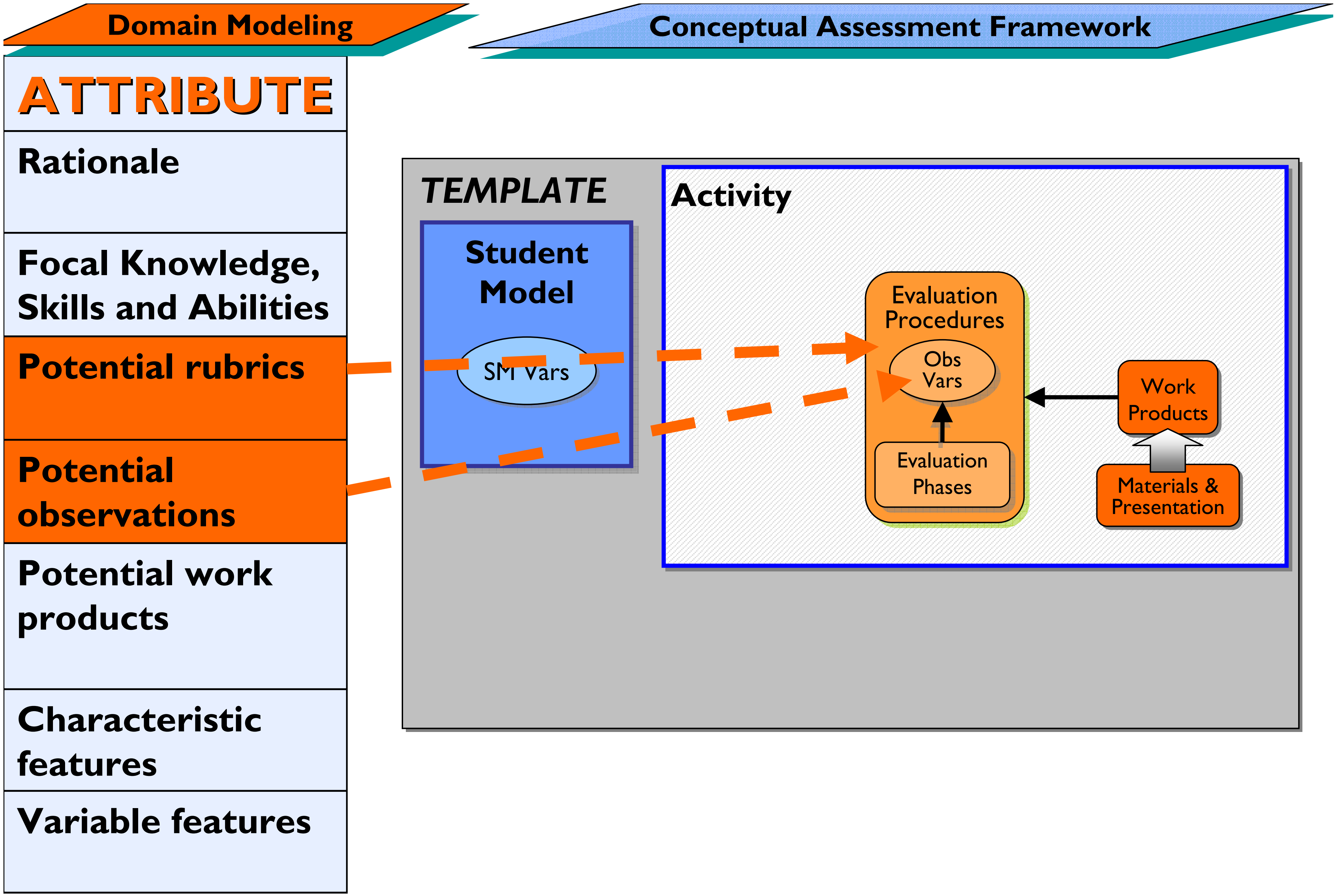
Student Model
SM Vars
Activity
Work Products
Materials & Presentation



Domain Modeling
Conceptual Assessment Framework
ATTRIBUTE
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Focal Knowledge, Skills and Abilities
Potential rubrics
Potential observations
Potential work products
Characteristic features
Variable features
TEMPLATE
Student Model
SM Vars
Activity
Evaluation Procedures
Obs Vars
Evaluation Phases
Work Products
Materials & Presentation

Domain Modeling

Conceptual Assessment Framework

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Potential rubrics
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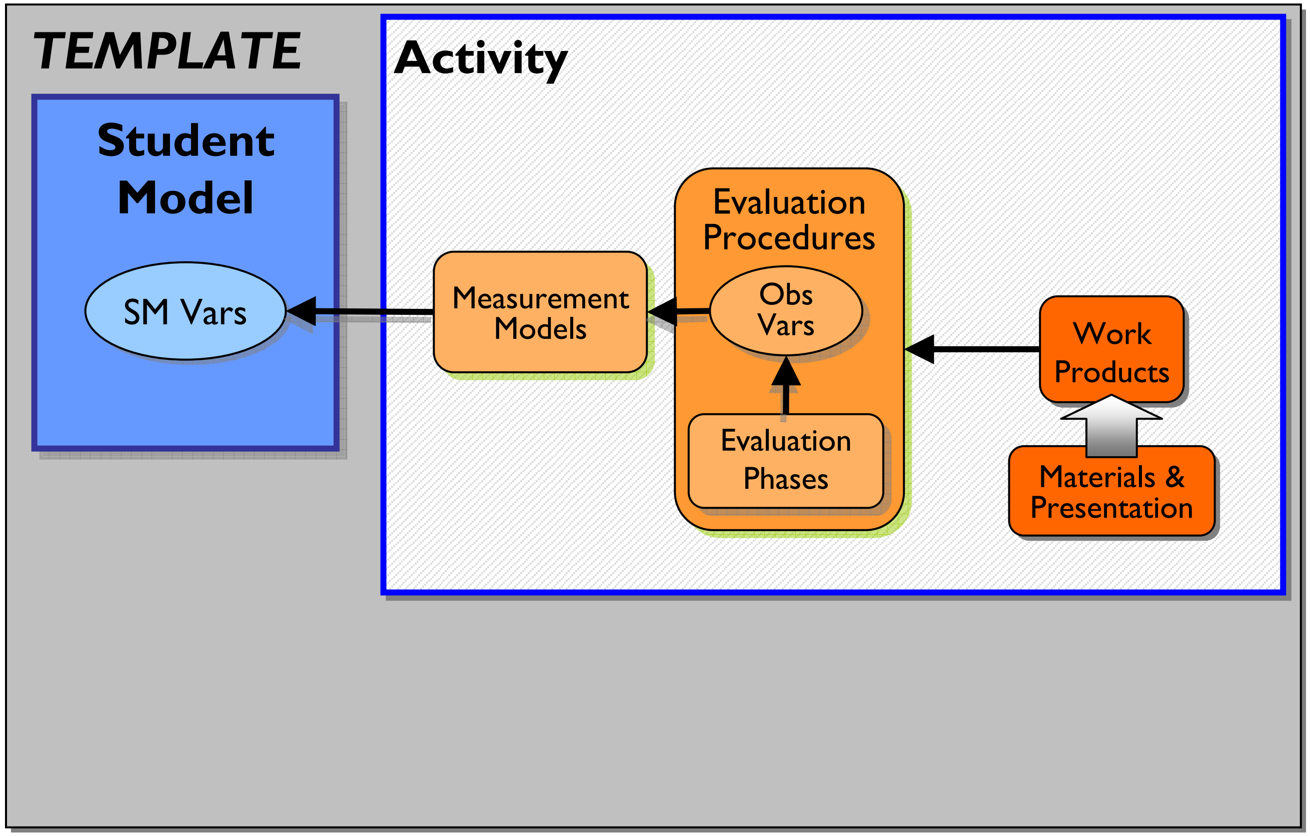
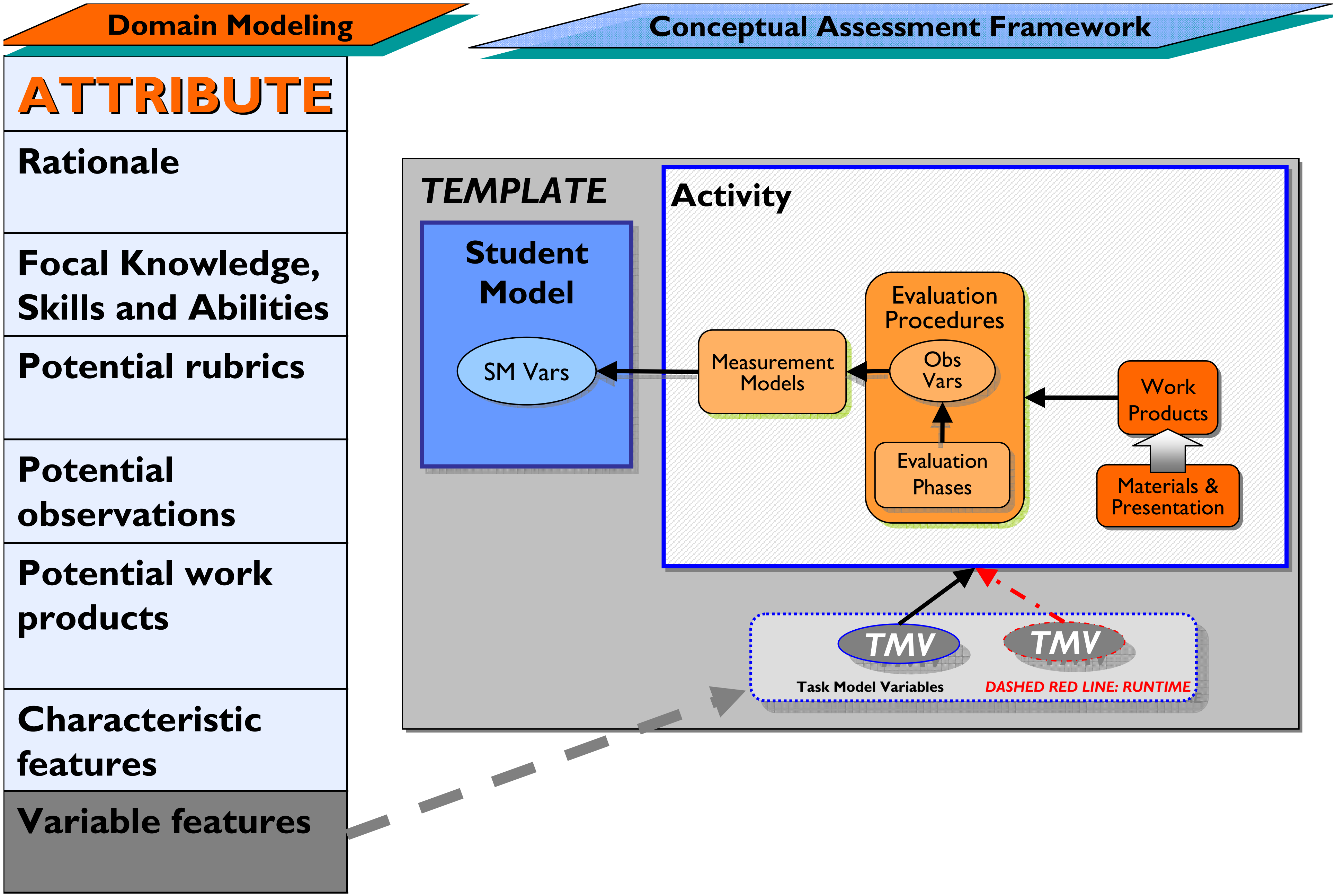
Potential work products
Characteristic features
Variable features

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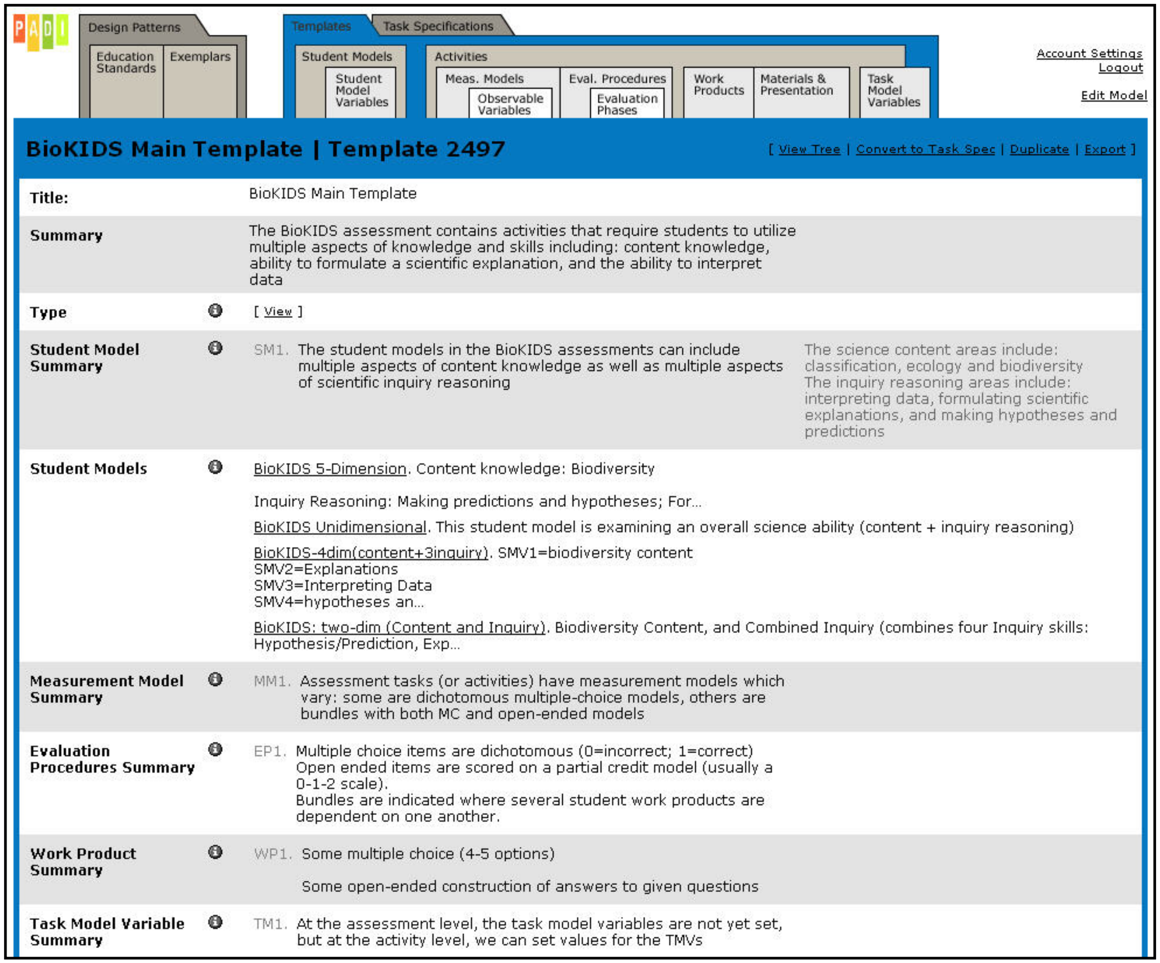
Student Model
SM Vars
Activity
Measurement Models
Evaluation Procedures
Obs Vars
Evaluation Phases
Work Products
Materials & Presentation
TMV
TMV
Task Model Variables
DASHED RED LINE: RUNTIME

Viewing Student Models

- For starters:
  - BioKIDS Main Template (#2497)

PADI Student Models from BioKIDS Main Template



BioKIDS Main Template | Template 2497

[View Tree | Convert to Task Spec | Duplicate | Export]

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		[View]
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 — The science content areas include: classification, ecology and biodiversity The inquiry reasoning areas include: interpreting data, formulating scientific explanations, and making hypotheses and predictions
Student Models		BioKIDS 5-Dimension. Content knowledge: Biodiversity Inquiry Reasoning: Making predictions and hypotheses; For... BioKIDS Unidimensional. This student model is examining an overall science ability (content + inquiry reasoning) BioKIDS-4dim(content+3inquiry). SMV1=biodiversity content SMV2=Explanations SMV3=Interpreting Data SMV4=hypotheses an... BioKIDS: two-dim (Content and Inquiry). Biodiversity Content, and Combined Inquiry (combines four Inquiry skills: Hypothesis/Prediction, Exp...
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 one another.
Work Product Summary		WP1. Some multiple choice (4-5 options) Some open-ended construction of answers to given questions
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

BioKIDS Main Template (contd)

Template-level Task Model Variables	Administration Type. Task may be administered via computer or via paper and pencil. Content area. Specific domain content under consideration
Task Model Variable Settings	[View]
Materials and Presentation Requirements	Ma1. Students are given a paper assessment and they must have something to write with
Template-level Materials and Presentation	
Materials and Presentation Settings	[View]
Activities Summary	AS1. Students are presented with several contexts, data, and/or representations and are asked to interpret data and build explanations in the given contexts.
Activities	Step 1, Simple task. In this type of task, students are presented with a scenario, given data/evidence and they must choo... Step 2, moderate open ended written response. Requires the formation of a scientific explanation (Claim + Evidence) - but has scaffolding for the ... Step 3 Complex open ended written response. Students are presented with an unscaffolded question and they must formulate an answer using the inf... Step 3, Complex Performance task. Students must manipulate a/some tool(s) of science or data in order to answer the question.
Tools for Examinee	Tf1. Written assessment with contextual scenarios, data, and activities Tf2. Writing implement
Exemplars	
Educational Standards	NSES 8ASI1.3. Use appropriate tools and techniques to gather, analyze, and interpret data. The use of tools and te... NSES 8ASI1.4. Develop descriptions, explanations, predictions, and models using evidence. Students should base the... NSES 8ASI1.5. Think critically and logically to make the relationships between evidence and explanations. Thinking... NSES 8ASI1.6. Recognize and analyze alternative explanations and predictions. Students should develop the ability ... NSES 8ASI2.5. Scientific explanations emphasize evidence, have logically consistent arguments, and use scientific ...

PADI Student Model

BioKIDS 5 Dimensions

Design Patterns | Education Standards | Exemplars | Templates | Task Specifications | Student Models | Student Model Variables | Activities | Meas. Models | Observable Variables | Eval. Procedures | Evaluation Phases | Work Products | Materials & Presentation | Task Model Variables

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Edit Model

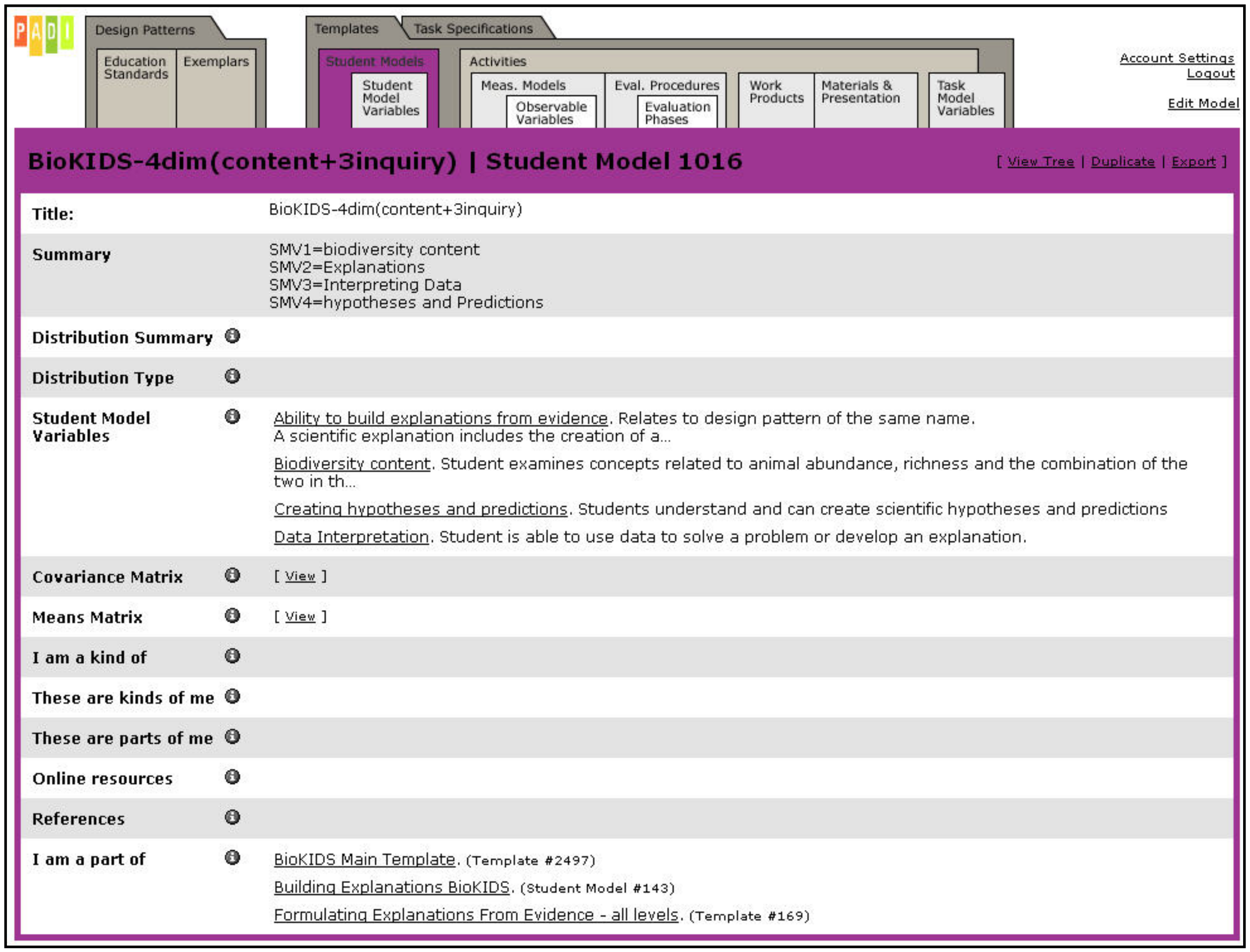
BioKIDS 5-Dimension | Student Model 1052

[View Tree | Duplicate | Export]

Title:	BioKIDS 5-Dimension
Summary	Content knowledge: Biodiversity Inquiry Reasoning: Making predictions and hypotheses; Formulating scientific explanations; Reexpressing data; Interpreting data
Distribution Summary	
Distribution Type	DT1. Multivariate normal
Student Model Variables	Biodiversity content. Student examines concepts related to animal abundance, richness and the combination of the two in th... Building Explanation from Evidence. BioKIDS Inquiry Skill Creating hypotheses and predictions. Students understand and can create scientific hypotheses and predictions Data Interpretation. Student is able to use data to solve a problem or develop an explanation. Reexpressing data. Students can use different kind of methods to express data
Covariance Matrix	[View] (Modified 2004-11-29) There are five Student Model Variables: 1: Biodiversity content 2: Hypothesis/ Prediction 3: Building Explanation from Evidence 4: Interpreting Data 5: Reexpressing Data
Means Matrix	[View]
I am a kind of	
These are kinds of me	
These are parts of me	
Online resources	
References	
I am a part of	BioKIDS - multidimFive. (Template #1070) BioKIDS Main Template. (Template #2497) Building Explanations BioKIDS. (Student Model #143) Formulating Explanations From Evidence - all levels. (Template #169)

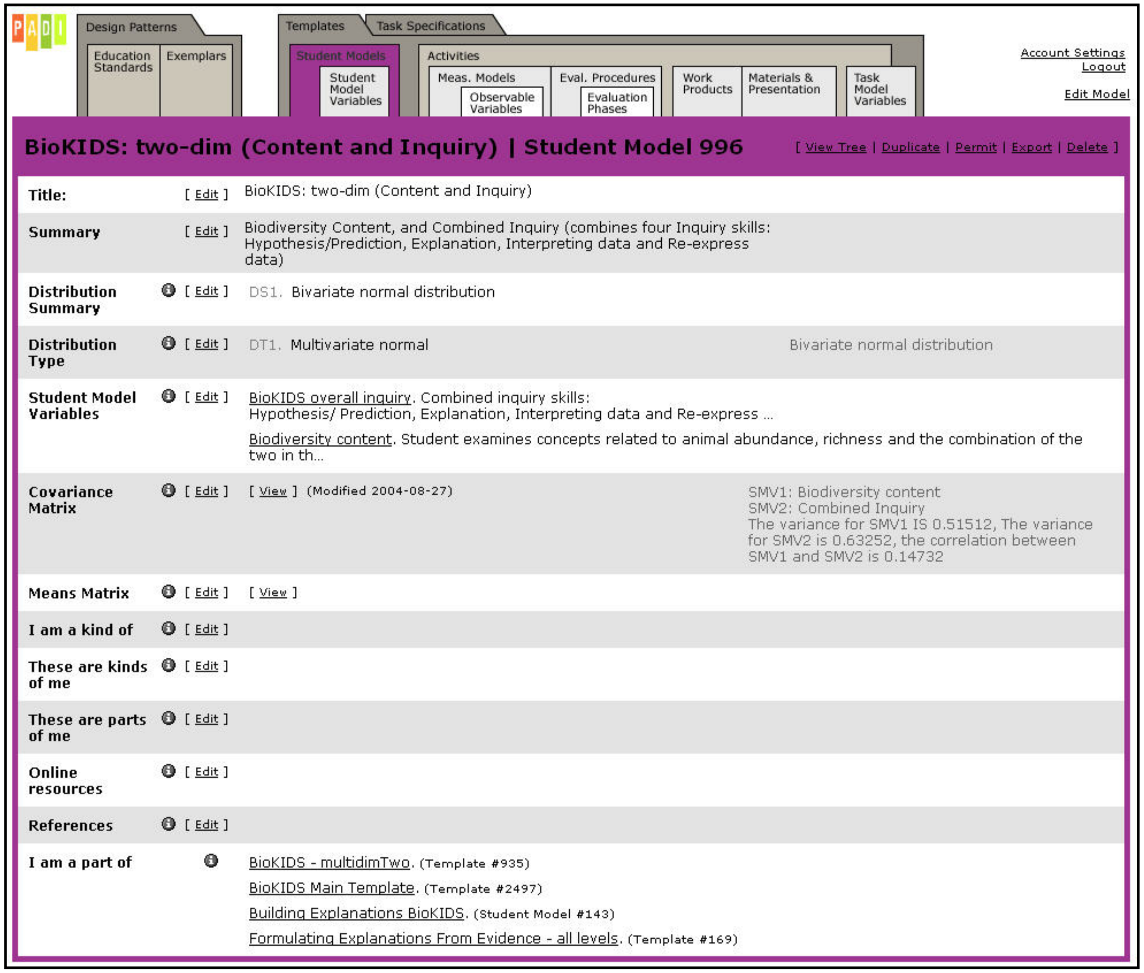
PADI Student Model

BioKIDS 4 Dimensions



PADI Student Model

BioKIDS 2 Dimensions



Design Patterns | Education Standards | Exemplars | Templates | Task Specifications | Student Models | Student Model Variables | Activities | Meas. Models | Observable Variables | Eval. Procedures | Evaluation Phases | Work Products | Materials & Presentation | Task Model Variables

Account Settings
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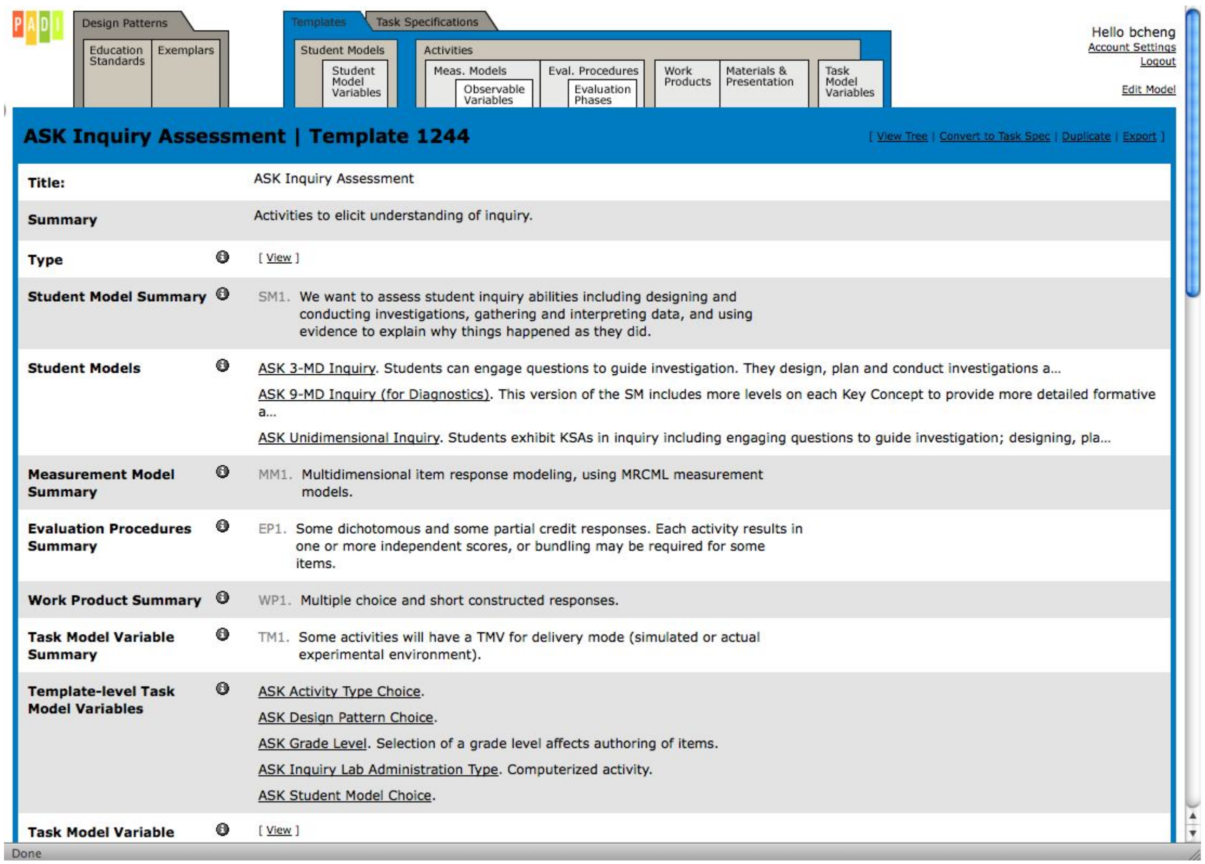
Edit Model

BioKIDS: two-dim (Content and Inquiry) | Student Model 996 [View Tree | Duplicate | Permit | Export | Delete]

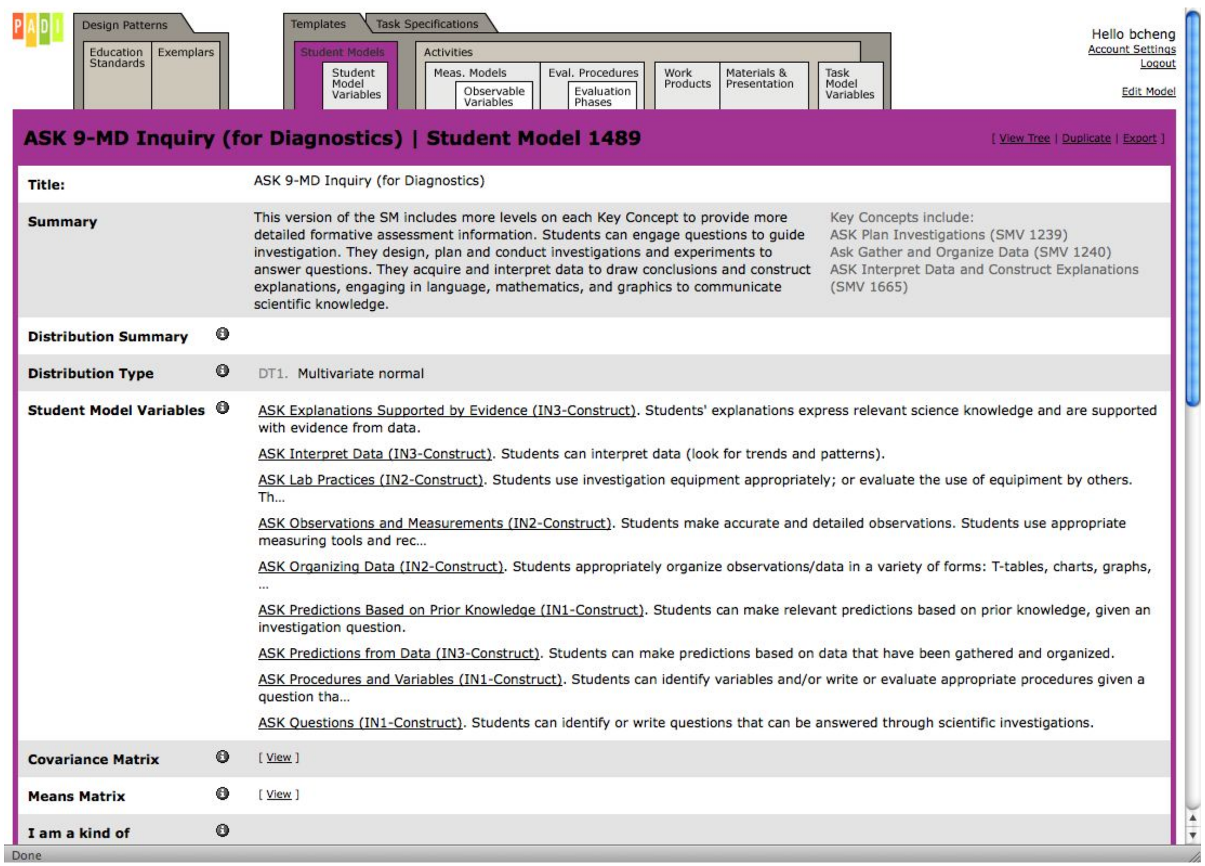
Title:	[Edit]	BioKIDS: two-dim (Content and Inquiry)
Summary	[Edit]	Biodiversity Content, and Combined Inquiry (combines four Inquiry skills: Hypothesis/Prediction, Explanation, Interpreting data and Re-express data)
Distribution Summary	[Edit]	DS1. Bivariate normal distribution
Distribution Type	[Edit]	DT1. Multivariate normal — Bivariate normal distribution
Student Model Variables	[Edit]	BioKIDS overall inquiry. Combined inquiry skills: Hypothesis/ Prediction, Explanation, Interpreting data and Re-express ... Biodiversity content. Student examines concepts related to animal abundance, richness and the combination of the two in th...
Covariance Matrix	[Edit]	[View] (Modified 2004-08-27) — SMV1: Biodiversity content SMV2: Combined Inquiry The variance for SMV1 IS 0.51512, The variance for SMV2 is 0.63252, the correlation between SMV1 and SMV2 is 0.14732
Means Matrix	[Edit]	[View]
I am a kind of	[Edit]	
These are kinds of me	[Edit]	
These are parts of me	[Edit]	
Online resources	[Edit]	
References	[Edit]	
I am a part of		BioKIDS - multidimTwo. (Template #935) BioKIDS Main Template. (Template #2497) Building Explanations BioKIDS. (Student Model #143) Formulating Explanations From Evidence - all levels. (Template #169)

PADI Student Models from FOSS (ASK) Main Template



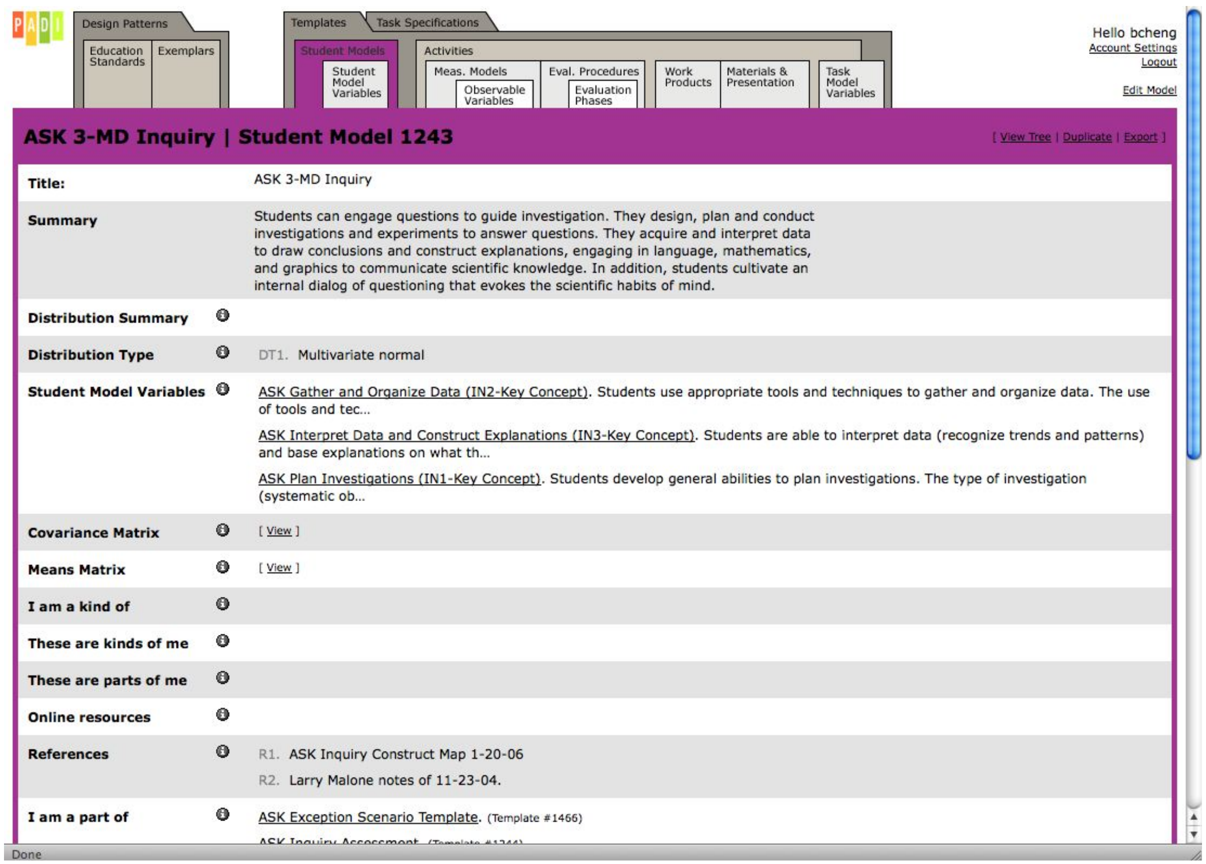
PADI Student Model

FOSS (ASK) 9 Dimensions



PADI Student Model

FOSS (ASK) 3 Dimensions



PADI Student Model

FOSS (ASK) 1 Dimension

Design Patterns | Education Standards | Exemplars

Templates | Task Specifications

Student Models | Student Model Variables

Activities | Meas. Models | Observable Variables | Eval. Procedures | Evaluation Phases | Work Products | Materials & Presentation | Task Model Variables

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ASK Unidimensional Inquiry | Student Model 1310 [View Tree | Duplicate | Export]

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	DT1. Univariate normal
Student Model Variables	ASK Inquiry SMV. A unidimensional variable of inquiry knowledge.
Covariance Matrix	[View]
Means Matrix	[View]
I am a kind of	
These are kinds of me	
These are parts of me	
Online resources	
References	R1. ASK Inquiry Framework of July 2004. R2. Larry Malone notes of 11-23-04.
I am a part of	ASK Exception Scenario Template. (Template #1466) ASK Inquiry Assessment. (Template #1244) ASK Model Scenario Template. (Template #1465) ASK New Inquiry Lab Template. (Template #1896) ASK Performance Template. (Template #1467)

Done

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)