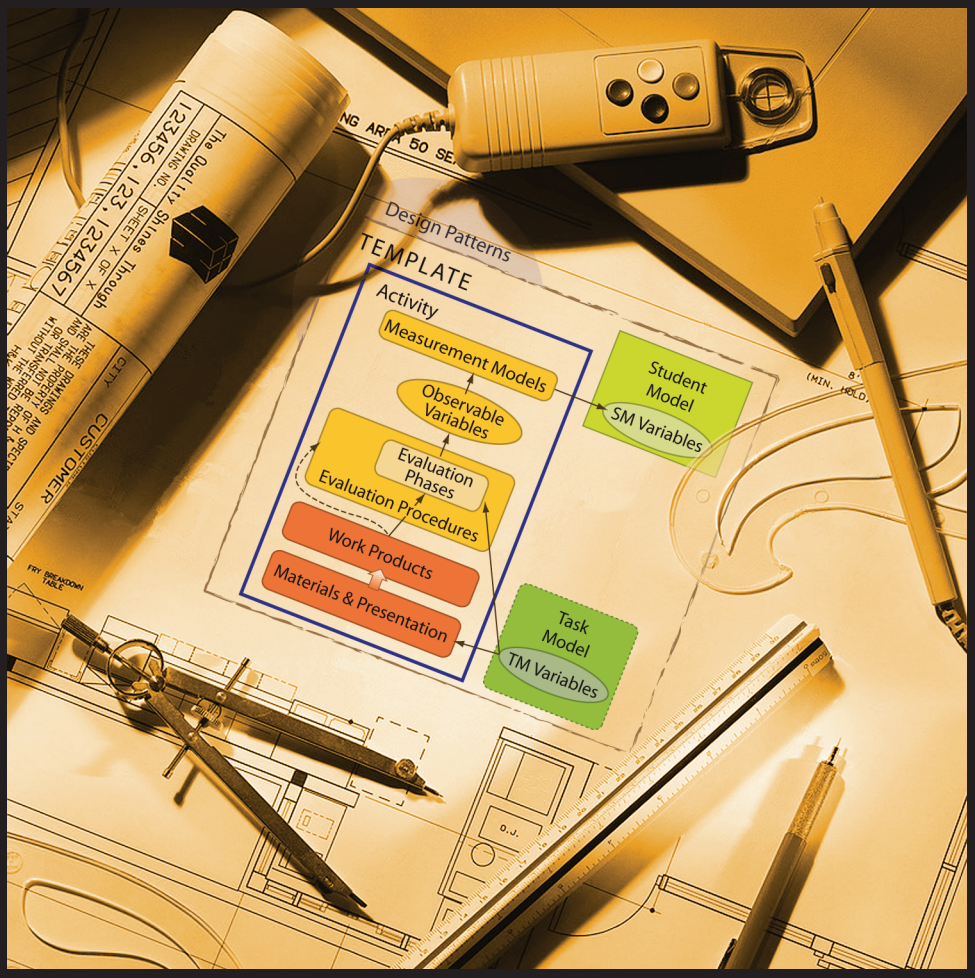

Large-Scale Assessment Technical Report 3|
October 2009

Narrative Structures in the Development of Scenario-Based Science Assessments

Project: Application of Evidence-Centered Design to State Large-Scale Science Assessment

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APPLICATION OF EVIDENCE-CENTERED DESIGN TO STATE LARGE-SCALE SCIENCE ASSESSMENT
TECHNICAL REPORT 3

Narrative Structures in the Development of Scenario-Based Science Assessments

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Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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Abstract

The Minnesota MCA-II Science test consists of scenario-based assessment tasks. Development of these tasks begins with the writing of storyboards, which serve as contexts for standards-aligned items. In the application of evidence-centered design to the MCA-II Science test, it was discovered that Narrative Structures are implicit features of storyboards. Narrative Structures are underlying frameworks on which storyboards are built. Narrative Structures can be identified, explicated, and distributed to storyboard writers to serve as advance organizers in the storyboard writing process. A study was conducted to determine if the explication of Narrative Structures in storyboard development improves the quality and efficiency of storyboard writing. Research and evaluative findings suggest that Narrative Structure recognition and use may aid in the storyboard writing process. Narrative Structures are treated as Variable Task Features in PADI *design patterns* and have been given their own attribute in the *design pattern* template.

1.0 PADI Design Patterns and Narrative Structures in MCA-II Science

The application of evidence-centered design (ECD: Mislevy, Steinberg, & Almond, 2002) in a technology-based large-scale assessment process is centered on the creation and use of Principled Assessment Designs for Inquiry (PADI) *design patterns*. PADI *design patterns* capture assessment design rationale in a reusable and generative form and can help assessment task designers think through substantive aspects of an assessment argument that span specific domains, forms, grades, and purposes. *Design patterns* consist of various attributes, including Knowledge, Skills, and Abilities (KSAs), Potential Work Products and Observations, and Characteristic and Variable Task Features (Mislevy, Hamel, et al., 2003). Table 1 shows the attributes of design patterns, in a form modified slightly for use with the MCA-II. An example of a design pattern from this project supports the development of tasks that include observational investigation (Mislevy, Liu, Cho, Fulkerson, Nichols, Zalles, Fried, Haertel, Cheng, DeBarger, Villalba, Colker, Haynie, & Hamel, 2009).

Table 1: Attributes of a PADI *Design Pattern*

Attribute	Definition
Title	A short name for referring to the design pattern.
Overview	Overview of the kinds of assessment situations students encounter in this design pattern and what one wants to know if they can do in terms of their knowledge, skills, and abilities.
Use	How the topic of the design pattern is an important aspect of scientific inquiry.
Focal KSAs	Primary knowledge/skills/abilities of students that one wants to know about.
Additional KSAs	Other knowledge/skills/abilities that may be required.
Potential observations	Some possible features of student performances that can provide evidence about the focal KSAs.
Potential work products	Different modes or formats in which students might produce the evidence.
Potential rubrics	Links to scoring rubrics that might be useful.
Characteristic features of tasks	Features of situations that are important for evoking the desired evidence.
Variable features of tasks	Kinds of features that can be varied in order to shift the difficulty or the focus of tasks.
Narrative Structures	Overall storyline of prompt(s). Helps to categorize and generate tasks
Benchmarks	Links to standards-based benchmarks for student assessment.
These are kinds of me	Links to other design patterns that are components or steps of this one.

I am part of	Links to other design patterns that this one is a component or step of.
These are parts of me	Links to other design patterns that are components or steps of this one.
Educational standards	Links to the most closely related NSES *Science as Inquiry* standards.
Templates (task/evidence shells)	Links to templates, at the more technical level of the PADI system, that use this design pattern.
Exemplar tasks	Links to sample assessment tasks that are instances of this design pattern.
Online resources	Links to online materials that illustrate or give backing for this design pattern.
References	Pointers to research and other literature that illustrate or give backing for this design pattern.

Within the context of the operational Minnesota Comprehensive Assessment Series II (MCA-II) Science test, the application of ECD to assessment extends design components and tools developed in the PADI project to exploit efficiencies that will streamline assessment design and development. The MCA-II Science test is scenario-based, and the development process begins with the writing of storyboards. Storyboards are precursors to scenarios and items, serving as the context to which standards-aligned items will be associated. Storyboards describe series of events or natural phenomena, thereby creating real-world contexts for assessment tasks. They are organized into four or five scenes, with each scene consisting of script text and art description that supports the assessment of one or more MCA-II Science benchmarks. Table 2 shows excerpts from a four-scene MCA-II Science storyboard.

Table 2: Excerpts from an Example MCA-II Science Storyboard

Storyboard Title: Snapping Turtles Life Science
Scene 1
Script Text: Snapping turtles are commonly found in ponds and rivers. Snapping turtles are characterized by webbed feet, hard shells, and sharp mouths.
Art Description: Art consists of an unlabeled still picture of a common snapping turtle. Listed characteristics are clearly displayed.
Scene 2
Script Text: Snapping turtles eat fish, invertebrates, amphibians, and carrion. Adult snapping turtles have few natural predators.
Art Description: Art shows a still picture of an adult snapping turtle with a frog in its mouth.
Scene 3
Script Text: Snapping turtles reproduce sexually. Female snapping turtles lay dozens of eggs at a time. The eggs are laid in sandy soil away from the water's edge. Offspring hatch underground and dig to the surface.

Art Description: Art shows a series of stills: 1) Adult snapping turtles in copulation, 2) Female snapping turtle laying eggs in a hole in sandy soil, 3) Young snapping turtles emerging from sandy soil.
Scene 4
Script Text: There are two species of snapping turtles in the United States. One species, the common snapping turtle, has many subspecies.
Art Description: A geographic map of North America showing the labeled ranges of the two snapping turtle species.

The extension of PADI design components in the application to an operational setting may require alterations to existing *design pattern* attributes and/or the addition of new *design pattern* attributes. Alterations or additions to design patterns may be necessary in order to capitalize on features inherent in the operational test development process or to minimize disruption to the operational test development workflow. Narrative Structures are a recently identified additional *design pattern* attribute. Narrative Structures are inherent features in MCA-II Science test development; all storyboards are structured according to at least one Narrative Structure. Narrative Structures were initially identified as undergirding components of storyboards during the development of *design patterns* for the MCA-II Science test. Largely unbeknownst to the storyboard writers, each newly written storyboard was implicitly based on one of six primary Narrative Structures. The storyboard writers' explication of these underlying structures made them available as a writing tool. Once recognized and described, these Narrative Structures could be distributed to storyboard writers for use during the storyboard writing process, thereby potentially increasing the efficiency of storyboard development by improving initial storyboard quality and/or reducing storyboard creation time. Thus, the identification, explication, and use of Narrative Structures represent a potential unexploited efficiency in the MCA-II Science test development process.

2.0 Narrative Structures, Dramatic Situations, and Movie Plots

Narrative Structures are general patterns or preconceived frameworks that serve as reusable plotlines for storyboards. They may be used as a type of advance organizer, aiding storyboard writers in the collection and organization of ideas and information prior to and during the storyboard writing process. They are potentially useful in the construction of a storyboard outline.

Narrative Structures were identified and described in a review of existing MCA-II Science storyboards. During this review, a number of storyboards were examined for literary structure and flow and categorized by common narrative features. Each category was then assigned a descriptive name and a characteristic definition. Six categories were identified, with each category representing a unique Narrative Structure. Following the initial review, each storyboard in the MCA-II Science storyboard pool (N=76) was examined and classified according to its primary Narrative Structure. All existing storyboards were readily classifiable into one of the six Narrative Structure categories; there were no outliers. This review revealed that MCA-II Science storyboards are inherently based on one of six primary Narrative Structures.

Prior to the recognition that Narrative Structures are inherent components of the storyboard development process, storyboard writers were asked to rely on their own methods and tools to organize thoughts, develop themes, and construct outlines. These tools may include trial-and-error, concept mapping, outlining, graphic representations, and other methods of organization. Essentially, storyboard writers were assigned a task and asked to create a storyboard without any significant direction. This condition often resulted in ambiguity, frustration, and inefficiency on the part of the storyboard writers. By recognizing, explicating, and distributing Narrative Structures to storyboard writers for use as advance organizers, efficiencies can be gained and frustration can be reduced.

Narrative Structures are similar to Georges Polti's 36 dramatic situations (Polti, 1921). Polti devised and published a descriptive, categorized list of every dramatic situation that might occur in a story. Examples of dramatic situations in Polti's list include loss,

rivalry, supplication, and deliverance. Polti's list is commonly used by novelists, storytellers, dramatists, and others to guide their work. Similarly, there are six Narrative Structures currently recognized for MCA-II Science development that describe common situations that might occur in a science storyboard.

When presented to MCA-II Science storyboard writers, Narrative Structures are introduced as analogous to basic plotlines for movies or novels. The following components are common elements of movie and novel plots:

- *Initial situation*: The first incident that sets the stage or initiates the story
- *Conflict/problem*: The goal that the main character of the story must achieve
- *Complication*: Obstacles that must be overcome to achieve the goal
- *Suspense*: A point of tension that heightens the interest of the audience
- *Climax*: The highest point of interest
- *Resolution*: The result of overcoming or failing to overcome the obstacles
- *Conclusion*: The end of the story

As a means of illustrating the elements of plots, the movie *E.T.: The Extra-Terrestrial* (Spielberg & Kennedy, 1982) can be considered. In *E.T.*, the initial situation is that a boy finds a lost alien, E.T. The problem is that E.T. wants to go home, but this is complicated by the fact that E.T. cannot contact the spaceship. The suspense in the movie revolves around E.T. trying to contact the spaceship before being captured by government agents. The movie climaxes at the chase scene (the flying bicycle).

Resolution occurs when E.T. returns to the spaceship and ultimately home, concluding in happiness and warm sentiment for the characters and the movie watchers alike. Similar to plotlines that direct the writing of movies and novels, Narrative Structures can direct storyboard writing by providing forms or frameworks for storyboards. Storyboard writers can utilize Narrative Structures to quickly and efficiently organize thoughts, develop a theme, and/or construct a storyboard outline.

3.0 Six Recognized Narrative Structures

Currently, six Narrative Structures are recognized in MCA-II Science storyboards:

1. *General to specific* or *Whole to parts*

   A general topic is initially presented followed by the presentation of specific aspects of the general topic.

   - Example: The water cycle includes the processes of evaporation, condensation, precipitation, sublimation, etc.
   - Example: The digestive system consists of the esophagus, stomach, liver, intestines, etc.

2. *Specific to general* or *Parts to whole*

   Specific characteristics of a system or phenomenon are presented, culminating in a description of the system or phenomenon as a whole.

   - Example: Atoms to molecules to compounds to matter in general
   - Example: Pieces of evidence for a given theory lead to a description of the theory itself (e.g., homologous structures as evidence for evolution)

3. *Investigation*

   A student or scientist completes an investigation in which one or more variables may be manipulated and data is collected.

   - Example: An experiment is performed in a classroom or laboratory
   - Example: Students participate in an observational study in an ecosystem

4. *Topic with examples*

   A given topic is presented using various examples to highlight the topic.

   - Example: Students visit the zoo to study adaptations by observing various animals
   - Example: Students study metals by examining the properties of different metallic elements

5. *Change over time*

   A sequence of events is presented to highlight sequential or cyclical change in a system.

   - Example: The sequence of protein synthesis
   - Example: The geological history of a landscape

6. *Cause and effect*

   An event, phenomenon, or system is altered by internal or external factors.

   - Example: A catalyst increases the rate of reaction
   - Example: Changing environmental pressures influence adaptations of organisms

The example storyboard shown in Table 2 is based on the “general to specific” Narrative Structure. In the example storyboard, the general topic is snapping turtles, and each scene highlights a specific aspect of snapping turtle biology:

- Scene 1: Snapping turtle physical characteristics
- Scene 2: Snapping turtle food sources
- Scene 3: Snapping turtle reproduction
- Scene 4: Snapping turtle distribution

4.0 A Study of Narrative Structure Use in Scenario-Based Assessment Development

In 2008, project researchers and evaluators conducted a study to learn if Narrative Structure use in MCA-II Science storyboard development increases the efficiency and quality of written storyboards. This study was conducted in an operational setting, with the products of the study slated to be field-tested in 2009 and potentially operationally tested in 2010.

To systematically examine the influence of the Narrative Structures on the performance of the storyboard writers, the study compared the performance of two groups: (1) storyboard writers who received training in the use of the Narrative Structures (NS); and (2) storyboard writers who did not receive training in the use of the Narrative Structures (non-NS). A total of 12 storyboard writers were assigned to groups based on several criteria: (1) experience teaching at a particular grade level; (2) gender; and (3) science content expertise. Because of the small number of individuals, writers were not randomly assigned to groups; rather, writers were specifically assigned to produce two groups that were similar in terms of teaching experience and science content expertise.

The 12 storyboard writers were asked to incorporate Narrative Structures into the 2008 storyboard writing process. The six previously described Narrative Structures in the form of a Narrative Structures information sheet (Appendix A) was distributed to the storyboard writers at the January 12, 2008 storyboard writing training workshop. This day-long training workshop was facilitated by professional large-scale assessment developers and was designed to equip item writers with the knowledge and skills necessary to create appropriate MCA-II Science storyboards. During the workshop, the experimental group (NS) received 25 minutes of special Narrative Structure training and was asked to use Narrative Structures in completing their first storyboard outline. The control group writers (non-NS) generated their first storyboard outlines during the workshop without training on or use of Narrative Structures; this group received 25 minutes of training in Narrative Structure use at the end of the workshop day. Following the training workshop, all storyboard writers were given an additional 30 minutes of

instruction in the use of Narrative Structures as tools to facilitate their independent storyboard writing process by applying the Narrative Structures as an organizer during the brainstorming, writing, and revising stages of storyboard development.

During the training session, the storyboard writers reviewed the Narrative Structures information sheet (Appendix A) and received the following directions:

> *"You are strongly encouraged to use Narrative Structures when writing your storyboards. Use Narrative Structures as you would any other graphic or textual organizer during the brainstorming, writing, and revising stages of storyboard development. It is possible to combine multiple Narrative Structures in the writing of a single storyboard. As you develop each storyboard, please complete the Storyboard Writer's Information Recording Sheet and submit the document with your storyboard."*

During the storyboard writing workshop, writers and facilitators offered some feedback on the use of Narrative Structures. During the training of the NS (experimental) group, the writers communicated that they already, intuitively, were using Narrative Structures, implying that these structures might not provide additional value. However, some writers suggested that Narrative Structures might support a newer writer by making the underlying frameworks explicit and therefore helping the writer to organize his/her thinking.

A total of 24 storyboards were created and reviewed during the course of this study. Professional large-scale assessment developers who oversee the development of the MCA-II Science test served as reviewers. The writing and reviewing process included the following components: (1) the writer generated a storyboard theme and outline, (2) a reviewer reviewed the theme and outline, (3) the writer wrote the storyboard, (4) the writer revised the storyboard, and (5) the reviewer reviewed the storyboard.

To document the influence of the Narrative Structures on the storyboard writers' performances, the storyboard writers were asked to complete and submit an information

sheet (Appendix B) with every completed storyboard. In the writer information sheets, data were collected from storyboard writers concerning the amount of time required to complete various components of the storyboard creation process. Storyboard reviewers were asked to complete and submit a review checklist for each completed storyboard (Appendix C), capturing data concerning the amount of time required to review the writers' work as well as quality ratings of different characteristics of the storyboards.

Additionally, at the end of the training workshop day, all writers participated in a 40-minute focus group (Appendix D) in which they discussed their storyboard writing process and perceptions of the benefits and limitations of using Narrative Structures in generating storyboard outlines. About a month after the workshop, following the completion of their storyboard writing assignments, ten storyboard writers completed an online survey (Appendix E) in which they offered feedback concerning the impact of Narrative Structures on their writing process. Information also was collected from the external advisory reviews of the storyboards for content and bias. Lastly, the storyboard pool was analyzed to study comparisons between storyboards created at the 2008 workshop and storyboards created in prior years. Key findings from the focus group and online survey, information sheets and checklists, external advisory reviews, and storyboard pool analysis are presented below.

4.1 Focus Group and Online Survey Findings

Key findings from the writers' focus group and on-line survey include:

- Writers were neutral about the contribution of Narrative Structures to their storyboard writing process this year, although they agreed that Narrative Structures should be used in future writing workshops and storyboard generation.
- Writers believed that Narrative Structures would be helpful to new writers by stimulating ideas, offering new options, and serving as a focal point.
- Although writers agreed that the Narrative Structures did not hinder their writing processes, they did not perceive that using these structures helped them generate storyboards more quickly.

- Some writers believed that the Narrative Structures would be more helpful to their future (than current) writing, suggesting a learning curve in applying Narrative Structures.
- Writers spoke of the difficulty of generating storyboard ideas/topics that fit with assigned benchmarks (typically 2-4 benchmarks); they did not believe Narrative Structures helped to solve this problem because Narrative Structures are related to the storyline, not generating original ideas.
- As solutions for idea generation, writers suggested that groups brainstorm storyboard topics (and possibly collaborate on storyboard writing) and that a tool be created to generate broad themes encompassing assigned benchmarks.

4.2 Information Sheet and Checklist Findings

Writer data were collected about 16 of the 24 storyboards written by the 12 writers using information sheets (Appendix B). Reviewer data were provided for all 24 storyboards using the review checklist (Appendix C). On the basis of these data, 16 storyboards were divided into those outlined or written with reference to Narrative Structures (called the NS group, N=8) and those neither outlined nor written with reference to Narrative Structures (called the non-NS group, N=8). Storyboards in the NS group were written for grades 3-5 (N=4 storyboards), grades 6-8 (N=2) and grades 9-12 (N=2); the non-NS group storyboards were written for grades 3-5 (N=1), grades 6-8 (N=3) and grades 9-12 (N=4).

Table 3 provides the timing results for the two groups of storyboards. Although no significant timing differences were found between the two groups, it should be noted that each storyboard written with reference to Narrative Structures required 23 fewer minutes to produce, on average, than storyboards written without reference to Narrative structures. This magnitude of difference, while not statistically significant, may have considerable practical significance in an operational test development process when the cumulative effect is considered.

Table 3. Average Timing Results for 2008 Storyboards Created With and Without Narrative Structures

Process Component* **(Chronologically arranged)**	**NS Group**	**Non-NS Group**	**Difference[1]**
Number of storyboards	*N=8*	*N=8*	
Generate theme / outline (writer)	84	60	+24
Review theme / outline (reviewer)	90	40	+50
Write storyboard (writer)	198	225	-27
Revise storyboard (writer)	8	17	-9
Final review (reviewer)	300	360	-60
Total writer time (derived)	**289**	**302**	**-13**
Total reviewer time (derived)	**390**	**400**	**-10**
Total time (derived)	**679**	**702**	**-23**

* Results are given in minutes.
[1] None of the differences were statistically significant

In reviewing the storyboards, the reviewers considered the extent to which each storyboard met initial review criteria, which are based on industry standards and Pearson best practices. For each of seven criteria, reviewers determined whether each storyboard met the criteria (score of 2), partially met the criteria (score of 1), or did not meet the criteria (score of 0). Table 4 provides these results. For each of the seven criteria, storyboards created with Narrative Structures were given equal or higher average ratings than those of the non-NS group. Combining the results across the 7 criteria, the NS storyboards were given slightly higher quality ratings on average than those generated without Narrative Structures. Qualitative comments offered by the reviewers for the storyboards differed somewhat between the two groups; a larger proportion of the NS storyboards needed changes/additions to the art or the actual scenes, whereas a larger proportion of the non-NS storyboards needed improvements to the flow or reduction in complexity of the storyboard.

Table 4. Average Initial Quality Reviews of 2008 Storyboards With and Without Narrative Structures

Initial Review Criteria	NS Group N=8	Non-NS Group N=8	Difference
Flow easily from scene to scene?	1.88	1.50	.38
Theme grade-appropriate?	2.00	1.75	.25
Support assigned benchmarks?	1.75	1.75	0
Grade-appropriate vocabulary?	1.75	1.63	.12
Sufficient scene descriptions?	1.50	1.25	.25
Appropriate references?	1.50	1.38	.12
Suitable benchmarks?	1.75	1.57	.18
Total score	**12.13**	**10.63**	**1.50**[1]

Scale: 0 = No, 1 = Partially, 2 = Yes

[1] This total score difference is not significant, p=0.07.

4.3 External Advisory Panel Findings

Following the storyboard writing and review process, all 2008 storyboards were subjected to expert content and bias reviews (March 2008) using Minnesota Department of Education external advisory panels. Advisory panel reviews for content and bias issues are standard components of the operational test development process. Panels consist of practicing Minnesota science teachers and other member of the educational community. During the content review, each storyboard was discussed in terms of various quality criteria, and concerns were raised. Neither the amount of discussion time (an average of 12-13 minutes for both NS storyboards and non-NS storyboards), nor the number of concerns, differed for the NS and non-NS groups of storyboards. The advisory panels' reviews yielded the following differences between the NS and non-NS groups' concerns about storyboards (these results are similar to those of the internal reviews).

- Artwork concerns were primary for NS storyboards (63%) and less so for the non-NS storyboards (25%)

- Script or text concerns were more common for non-NS storyboards (50%) than for NS storyboards (25%)
- Content/theme concerns were identified for 13% (one storyboard) of the non-NS storyboards

These results, coupled with previous results from the internal review, suggest a possible causal link between use of Narrative Structures and improvements in the overall text flow of the storyboard. Based on the content review, storyboard acceptance rates did not differ for the two groups. For the bias review, there were no differences in the storyboard review time or acceptance rates (100%) for the two groups of storyboards.

At the external advisory reviews, the 2008 storyboards (N=24) were reviewed alongside a group of previously created storyboards (N=12). The set of 12 previously created storyboards consisted of storyboards that were created but not selected for testing in previous development cycles and were revised for the March 2008 advisory panel review. Since the same advisory panels reviewed both sets of storyboards, these results can serve as a reasonable comparison between the two groups of storyboards. For the content review, there was a significant difference ($p < .0001$) in discussion time between 2008 storyboards (average = 13.5 minutes) and baseline storyboards (average = 27.6 minutes). However, this was likely to be due to a significant order effect during the review – more baseline storyboards were reviewed earlier in the day during the advisory review ($p<.0001$), and earlier reviews tended to require more discussion time (Pearson staff, personal communication, April 2008). The number of concerns indicated by reviewers differed significantly for the two groups; 2008 storyboards averaged 0.54 concerns each, and baseline storyboards averaged 1.17 concerns each ($p = .02$). There were some differences in the types of concerns for the two groups:

- Artwork concerns were primary for 2008 storyboards (45%) and less so for the baseline storyboards (33%)
- Baseline storyboards were more likely to incur concerns about content and theme (20% for baseline, compared with 8% for 2008 storyboards)

- Benchmark concerns were found for 32% of the baseline storyboards and none of the 2008 storyboards ($p<.0001$)

Though there was no difference in the acceptance rates between the two groups at content review (92% for both groups) or at bias review (100% for both groups), these data overall suggest an increase in writing quality (particularly in terms of alignment with the benchmarks) from the baseline to 2008.

In interpreting these results it is important to note, primarily, that although many of the same writers created storyboards in 2008 and during the baseline period as well, these writers were more experienced in 2008 (e.g., another year of writing/training under their belts). It should also be noted that the Narrative Structures were utilized for approximately one third of the 2008 storyboards. Finally, because the baseline storyboards were reviewed in previous years and not selected for any previous tests, many of them may have had deeper content issues requiring attention than a "fresh" pool of storyboards.

4.4 Storyboard Pool Analysis

During the study, a comparison also was made between the newly created storyboards (January 2008) and baseline storyboards. Baseline storyboards (N=76) included all storyboards created during MCA-II test development prior to the January 2008 training workshop. These storyboards were created between June 2005 and March 2007 before the recognition or understanding of Narrative Structure use in storyboard development. Criteria for comparison included types of Narrative Structures used (implicitly or explicitly), quality, time required, and acceptance rates.

Table 5 provides the patterns of use of Narrative Structures for baseline storyboards (created before 2008) and 2008 storyboards. The Narrative Structures were implicit in the baseline storyboards and retrospectively identified by a test development professional familiar with MCA-II storyboard development. Results in Table 5 indicate

percentage gains (from baseline to 2008) for some of the more complex Narrative Structures (e.g., change over time, specific to general), as well as a more uniform distribution in 2008 across the different Narrative Structure types. However, some caveats must be mentioned. The 2008 data were reported by the writers in the online survey and represent the number of times a Narrative Structure was used in creating any storyboard (13 uses of Narrative Structures across 8 storyboards). However, the baseline ratings, completed by only one internal reviewer, represent one Narrative Structure per storyboard. Thus, this comparison incorporates two different rating systems. Nevertheless, these data suggest that explicit use of Narrative Structures prompt the creation of less common storyboard types.

Table 5. Patterns of Use of Narrative Structures

	Baseline	2008	% Gain
1. General to specific	14 (18%)	3 (23%)	+5%
2. Specific to general	2 (3%)	2 (15%)	+12%
3. Investigation	36 (41%)	3 (23%)	-18%
4. Topic with examples	22 (29%)	1 (8%)	-21%
5. Change over time	4 (5%)	3 (23%)	+18%
6. Cause and effect	3 (4%)	1 (8%)	+4%
Total uses	76 (100%)	13 (100%)	

4.5 Conclusion

Findings from this study are not conclusive as to whether Narrative Structures improve quality and increase efficiency in the storyboard writing process. However, it is clear that Narrative Structures are implicit components in storyboard writing. Furthermore, the identification and explication of Narrative Structures does not appear to hinder the storyboard writing process and may actually benefit individual storyboard writers. Consequently, Narrative Structures should be incorporated into PADI *design patterns* for use in MCA-II Science task development.

5.0 Narrative Structures as Attributes of Design Patterns

Based on the results from the 2008 study suggesting their potential benefits, Narrative Structures were incorporated into PADI *design patterns* created for use in MCA-II Science storyboard development. Narrative Structures for the MCA-II Science storyboards are actually a Variable Task Feature—but one of sufficient importance to merit its own attribute in the *design pattern*.

The Narrative Structure attribute of *design patterns* noted above is reflected in the *MCA-II Science Test Specifications for Science* (Minnesota Department of Education, 2008) that is derived from the *Minnesota K-12 Academic Standards* (Minnesota Department of Education, 2003). The *Test Specifications* go beyond the statements of *Standards* themselves by further suggesting the kinds of reasoning and some of the features of tasks that are appropriate to include on the MCA-II Science test to assess students at the given grade levels. These additional parameters are called "content limits." Some Narrative Structures are implied in the content limits, and others are explicitly articulated.

For example, a content limit for Grade 8 benchmark 8.I.B.1 (Figure 1) in the History and Nature of Science strand states that gathering evidence to prove that continents move constitutes a demonstration of the knowledge that scientific investigations involve the common elements of systematic observation, careful collection of relevant evidence, logical reasoning, and innovation in developing hypotheses and explanations. Thus, this content limit and its relationship to its benchmark indicate two Narrative Structures: "topic with examples" and "change over time." To take another example, the Narrative Structure "specific to general" is clearly specified in Grade 8 benchmark 8.I.B.2 (Figure 1), which requires students to describe how scientists can conduct an investigation in a simple system and make generalizations to more complex systems. Two more specific examples are used in its content limits: observations of the impact of penicillin on bacteria can lead to the generalization that penicillin can cure certain illnesses and observations of convection can help students study weather patterns. These examples support the incorporation of Narrative Structures into *design patterns* as a special kind

of Variable Task Feature, warranting the Narrative Structure as an attribute in its own right in *design patterns* that support MCA-II Science task development.

Figure 1: Benchmarks 8.I.B.1 and 8.I.B.2 from *MCA-II Test Specifications for Science*.

8.I.B.1

The student will know that scientific investigations involve the common elements of systematic observations, the careful collection of relevant evidence, logical reasoning and innovation in developing hypotheses and explanations.

Content Limit:

Examples of scientific investigations that involve these common elements include gathering evidence that shows that continents have and are moving (such as continental coastlines, fossil records, matching landforms, and glacial evidence), and Mendel's work resulting in predictable relationships for characteristics of offspring and parents.

An example of logical reasoning is using evidence to change the focus of scientific investigation from how could continents move to determining what was driving their motion.

8.I.B.2

The student will describe how scientists can conduct investigations in a simple system and make generalizations to more complex systems.

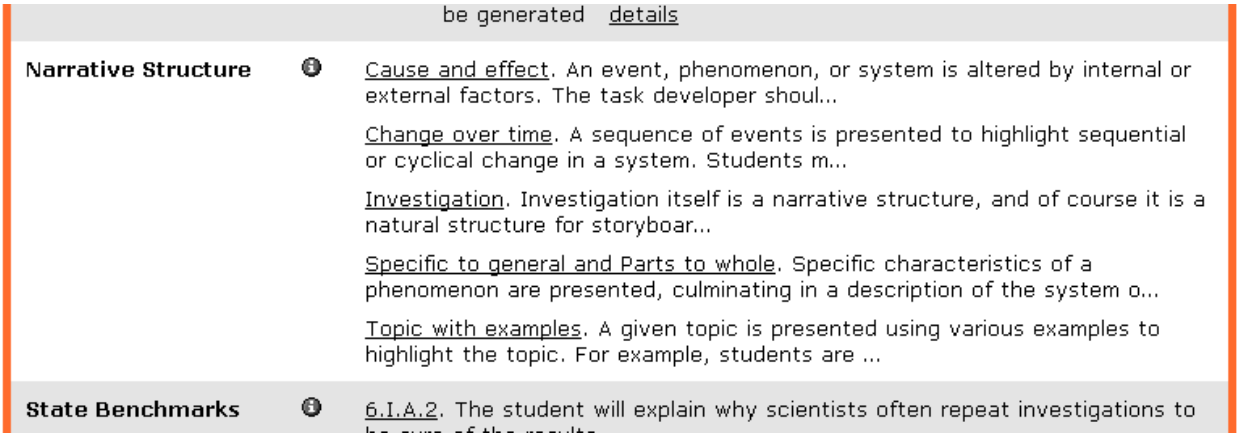
Content Limit:

Investigations include using observations of the impact of penicillin on bacteria to generalization of penicillin can cure certain illnesses, and using observations of convection to study weather patterns.

Simple systems have only one variable or factor, complex systems have multiple factors involved.

Figure 2 shows the Narrative Structure attribute incorporated in the Observational Investigation *design pattern*, developed for the MCA-II Science assessment (Mislevy, Liu, Cho, Fulkerson, Nichols, Zalles, Fried, Haertel, Cheng, DeBarger, Villalba, Colker, Haynie, & Hamel, 2009); for the complete design pattern, see http://design-drk.padi.sri.com/padi/do/AddNodeAction?NODE_ID=2167&state=viewNode). Five Narrative Structures were identified that lend themselves particularly well to Observational Investigation scenarios: Specific to general and Parts to whole, Topic with examples, Investigation, Change over time, and Cause and effect.

Figure 2: Narrative Structure as an Observational Investigation design pattern attribute.



Subsequent *design patterns* crafted for the MCA-II Science test will incorporate Narrative Structures as a Variable Task Feature. In all future storyboard development cycles, writers will be encouraged to use Narrative Structures as they would use any other Variable Task Feature. During each cycle of development, data will be collected regarding Narrative Structure use and its potential impact on the storyboard writing process. As PADI *design patterns* are applied in MCA-II Science test development, it is expected that the explication and distribution of Narrative Structures will serve to increase the efficiency of the storyboard writing process and improve the quality of the storyboard writing product.

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Appendix A – Narrative Structure Information Distributed to the Storyboard Writers During the 2008 Storyboard Writing Workshop

Narrative Structures & Storyboard Writing
Storyboard Writing, January 2008

Introduction
Narrative Structures have been developed as part of the NSF-funded DR K-12 research project. This project is studying the incorporation of evidence-centered test design into large-scale, technology-based assessments.

Narrative Structures are tools to help you organize thoughts, develop a theme, and/or construct a storyboard outline. Narrative Structures serve as a type of advanced organizer for storyboard writing.

Narrative Structures and Movie Plots
You may find it useful to think of Narrative Structures as analogous to basic plotlines for movies or novels. For example, a common movie structure/plot may consist of the following elements:

- *Initial situation*: The first incident that sets the stage or initiates the story
- *Conflict/problem*: The goal that the main character of the story must achieve
- *Complication*: Obstacles that must be overcome to achieve the goal
- *Suspense*: A point of tension that heightens the interest of the audience
- *Climax*: The highest point of interest
- *Resolution*: The result of overcoming or failing to overcome the obstacles
- *Conclusion*: The end of the story

Many movies follow this plot. In the movie *E.T.*, for example, the initial situation is that a boy finds a lost alien, E.T. The problem is that E.T. wants to go home, but this is complicated by the fact that E.T. cannot contact the spaceship. The suspense in the movie revolves around E.T. trying to contact the spaceship before being captured by government agents. The movie climaxes at the chase scene (the flying bicycle). Resolution occurs when E.T. returns to the spaceship and ultimately home, concluding in happiness and warm sentiment for the characters and the movie watchers alike.

In a similar way, Narrative Structures can direct storyboard writing by providing forms or frameworks for storyboards.

The Six Narrative Structures

Currently, the DR K-12 project team recognizes six Narrative Structures.

1. *General to specific* or *Whole to parts*
   A general topic is initially presented followed by the presentation of specific aspects of the general topic.
   - Example: The water cycle includes the processes of evaporation, condensation, precipitation, sublimation, etc.
   - Example: The digestive system consists of the esophagus, stomach, liver, intestines, etc.

2. *Specific to general* or *Parts to whole*
   Specific characteristics of a system or phenomenon are presented, culminating in a description of the system or phenomenon as a whole.
   - Example: Atoms to molecules to compounds to matter in general
   - Example: Pieces of evidence for a given theory lead to a description of the theory itself (e.g., homologous structures as evidence for evolution)

3. *Investigation*
   A student or scientist completes an investigation in which one or more variables may be manipulated and data is collected.
   - Example: An experiment is performed in a classroom or laboratory
   - Example: Students participate in an observational study in an ecosystem

4. *Topic with examples*
   A given topic is presented using various examples to highlight the topic.
   - Example: Students visit the zoo to study adaptations by observing various animals
   - Example: Students study metals by examining the properties of different metallic elements

5. *Change over time*
   A sequence of events is presented to highlight sequential or cyclical change in a system.
   - Example: The sequence of protein synthesis
   - Example: The geological history of a landscape

6. *Cause and effect*
   An event, phenomenon, or system is altered by internal or external factors.
   - Example: A catalyst increases the rate of reaction
   - Example: Changing environmental pressures influence adaptations of organisms

Using Narrative Structures

You are strongly encouraged to use Narrative Structures when writing your storyboards. Use Narrative Structures as you would any other graphic or textual organizer during the brainstorming, writing, and revising stages of storyboard development. It is possible to combine multiple Narrative Structures in the writing of a single storyboard. As you develop each storyboard, please complete the Storyboard Writer's Information Recording Sheet and submit the document with your storyboard.

As always, please contact your Pearson content specialist with questions or concerns.

Appendix B – The Storyboard Writers' Information Recording Sheet

Storyboard Writer's Information Recording Sheet
Please submit this form with each storyboard. Thank you.

<table>
<tr><td>Author:</td><td>Time spent Generating your Theme and Major Points:</td><td>Time spent Writing your Storyboard (before submission):</td><td>Time spent Revising your Storyboard (after Pearson review) (if applicable):</td></tr>
<tr><td>Storyboard #:</td><td>Starting Time:</td><td>Starting Time:</td><td>Starting Time:</td></tr>
<tr><td>Assigned Benchmark(s):</td><td>Ending Time:</td><td>Ending Time:</td><td>Ending Time:</td></tr>
<tr><td>Type: Investigation
Phenomena
Data Analysis</td><td>Total Time:</td><td>Total Time:</td><td>Total Time:</td></tr>
<tr><td>Is this your 1st or 2nd Storyboard for 2008?
1st 2nd</td><td>Did you use a Narrative Structure?
Yes No</td><td>Did you use a Narrative Structure?
Yes No</td><td rowspan="3">Comments:</td></tr>
<tr><td rowspan="2"></td><td>If so, which one(s)?
(list)</td><td>If so, which one(s)?
(list)</td></tr>
<tr><td>Was the Narrative Structure a help or hindrance? Why?:</td><td>Was the Narrative Structure a help or hindrance? Why?:</td></tr>
</table>

Appendix C – Storyboard Reviewer Checklist

Storyboard Review Checklist – January 2008

Reviewer			
Storyboard Number			
Grade			
Theme			
Author			
Initial Review* date:			
starting time:			
ending time:			
total time:			
Criteria (circle)			
Does the storyboard have a central theme and flow easily from scene to scene?	Yes Partially No	Yes Partially No	Yes Partially No
Is the storyboard's theme grade-appropriate?	Yes Partially No	Yes Partially No	Yes Partially No
Do the scenes support the assigned benchmarks?	Yes Partially No	Yes Partially No	Yes Partially No
Does the script text contain grade-appropriate vocabulary?	Yes Partially No	Yes Partially No	Yes Partially No
Are the detailed scene descriptions sufficient?	Yes Partially No	Yes Partially No	Yes Partially No
Are appropriate references included?	Yes Partially No	Yes Partially No	Yes Partially No
Are suitable benchmarks proposed?	Yes Partially No	Yes Partially No	Yes Partially No
Comments/Describe Revisions Needed			
Final Revisions+ starting time:			
ending time:			
total time:			
Comments/Describe Revisions Made			

* Following initial storyboard draft + Following final teacher revisions

Appendix D – Questions for Storyboard Writers' Focus Group, 1/12/08

Ask permission to audiotape for evaluative purposes?

Introductions: name, grade, content area

Questions:

(Group 2 – no NS) 1. Think about your process of generating a storyboard outline. What challenges are there in coming up with ideas? What do you do to meet these challenges?

(Group 2 – no NS) 2. Having had an introduction to narrative structures, what benefits do you anticipate in using these to write storyboards?

(Group 1 – NS) 3. Think about your "normal" process of generating a storyboard outline. What challenges are there in coming up with ideas? What do you do to meet these challenges?

(Group 1 - NS) 4. Think about your use, today, of a narrative structure in generating storyboard ideas.

a. Did the narrative structure help? Why or why not? Did it help in terms of speed? Did it help in terms of coming up with "better" ideas?

b. How did you choose a narrative structure to go with your benchmark, or was it assigned to you? Was it an easy narrative structure to work with? Why or why not?

c. Put yourself back in your own shoes earlier this weekend, with benchmark and a narrative structure in front of you, trying to come up with a good outline. What was your thought process for coming up with an outline? How did the narrative structure inform your thinking? Did it prompt you to make new associations in any way?

5. Now, think generally about your development as a storyboard writer. Are there new things you are coming understanding about writing assessments? Perhaps about relationships between the storyboard/task you are writing and the things you actually want to measure? Are there things you have learned about writing assessments this weekend? What brought about your new learning?

Appendix E – Survey Questions Post-Storyboard Writing, March 2008

Your Grade Band: 3-5 6-8 High School

Please indicate the number of years you have been involved in storyboard writing with Pearson:

4 (since 2005) 3 (since 2006) 2 (since 2007) 1 (starting 2008)

Number of storyboards submitted this cycle (2008): 0 1 2+

Please write a quick description of your first storyboard: _____

If applicable, please write a quick description of your second storyboard: _____

Which, if any, narrative structures did you use in completing your storyboard(s)?

Narrative Structure	First Storyboard	Second Storyboard
General to Specific, or Whole to Parts For example, storyboard begins with a general topic (e.g. frogs) and discuss specific characteristics of the topic (e.g. feeding, breeding, migration, etc.)		
Specific to General, or Parts to Whole For example, storyboard begins with atoms, move to molecules, compounds, and mixtures, end with a discussion on matter in general		
Investigation: For example, the student manipulates something and data is collected		
Topic with examples: For example, a character visits the zoo and scenes present examples of different animals		
Change over time ** Add example		
Cause and effect **Add example		

Please indicate your agreement with the following statements about the narrative structures and the storyboard writing process in 2008.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	not applicable
In the past (before 2008), it was easy to generate ideas for storyboards						
It was difficult to find a narrative structure that helped me write my storyboard(s)						
The narrative structure(s) helped stimulate my ideas or associations with the content/benchmark						
Using narrative structure(s) helped me think about the content/ benchmark in a new way						
The narrative structure(s) helped me think of scenes associated with the content/benchmark						
Using narrative structure(s) helped me generate a storyboard outline more quickly						
Using narrative structure(s) helped me generate a storyboard more quickly						
After writing my first storyboard, I was able to use the narrative structures more efficiently for writing subsequent storyboards						
My storyboard writing has improved this year, compared to previous years.						
If I use narrative structures for storyboard writing again, I predict that the narrative structures will become increasingly useful as I gain more experience with them.						
The narrative structure(s) was a hindrance to my writing process.						
Other:						

What, if anything, did you find especially helpful about the using the narrative structures in your storyboard writing?

What, if anything, did you find especially difficult or challenging about using the narrative structures in your storyboard writing?

Would you recommend that the narrative structures be used in storyboard writing in the future?

a. absolutely not
b. maybe, but probably not
c. probably yes
d. absolutely yes

Do you have any suggestions to Pearson for how the process of using narrative structures in storyboard writing can be improved?

Anything else you would like us to know? _____

THANK YOU for your time and participation!

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