Development of Illustrations as Image Supports for English Language Learners in Large-Scale Testing: A Report on the Procedure for Designing Vignette Illustrations

Guillermo Solano-Flores
University of Colorado at Boulder

Abstract

This paper presents a framework and a procedure for developing vignette illustrations as a form of testing accommodation for English language learners (ELLs). Vignette illustrations are defined as illustrations added to test items originally created without illustrations, with the intent to provide a visual support for ELLs that increases their chances of accessing the content of those test items. The development of both the framework and the procedure are part of the activities of the National Science Foundation-funded project, "Design and Use of Illustrations in Test Items as a Form of Accommodation for English Language Learners in Science Assessment," whose ultimate goal is to identify whether and how the presence of vignette illustrations produces substantial differences in the performance of ELLs on science tests by minimizing language proficiency in the language of testing as a source o measurement error. The framework provides developers with the reasonings needed to think about the vignette illustrations they need to develop; it postulates the existence of several functions of illustrations, formalizes a set of basic principles for the design of vignette illustrations, and proposes a visual grammar for examining illustrations. The procedure establishes the actions and conditions needed to properly develop the vignette illustrations; it establishes a set of dimensions that testing programs and test developers need to take into consideration in order to standardize the characteristics of the vignette illustrations used, identifies the professionals that should participate in the process of illustration development, and establishes the steps that need to be taken to develop the vignette illustrations.

Guillermo.Solano@Colorado.edu

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Introduction

The project, "Design and Use of Illustrations in Test Items as a Form of Accommodation for English Language Learners in Science Assessment" (DRL 0822362) (Note 1) addresses the urgent need for valid forms of testing accommodation for English language learners (ELLs)—students who are developing English as a second language while they are still developing their first language. We are investigating the factors that are relevant to designing a new form of testing accommodation—vignette illustrations—and its effectiveness in minimizing limited language proficiency in the language of testing as a source of measurement error.

The project is in its third and last year of funding. Currently, we are giving ELL and non-ELL students multiple choice science test items with and without the vignette illustrations we created using a framework and a procedure for developing vignette illustrations. Vignette illustrations should be considered to be an effective form of accommodation if we find out that: (1) ELLs tend to perform better on vignette-illustrated than non-illustrated items; and (2) the performance of non-ELLs on vignette-illustrated and non-illustrated items is comparable—a proof that the accommodation operates on factors directly related to the language proficiency of ELLs. In addition, we are examining score variation due to vignette illustrations; we intend to determine the extent to which the presence of an illustration interacts with the characteristics of the students and the content of the items and the extent to which that interaction shapes the effectiveness of this form of testing accommodation.

This paper focuses on the procedure for creating vignette illustrations—a procedure which has taken over two years to develop and refine. It discusses the multiple conceptual and procedural aspects that we have identified as critical to properly developing this form of accommodation. The conceptual support for our approach comes from multiple fields, including literacy (Cope & Kalantzis, 2000; Kress & van Leeuwen, 2001), cognitive science (Mayer, & Sims, 1994; Paivio 1971, 2006), and linguistics and sociocultural theory (Vygotsky, 1978; Wertsch, 1985). The paper does not discuss empirical evidence of effectiveness, as empirical data are currently being collected. Also, due to space limits, the paper does not provide a detailed discussion of the methodology used to assess the effectiveness of this form of accommodation.

Need for effective testing accommodations

In the context of ELL testing, testing accommodations are defined as modifications in the ways tests are administered or responded to with the intent to minimize limited proficiency in English as a threat to the validity of test scores and without altering the constructs measured by tests (Abedi, Hofstetter, & Lord, 2004). While the inclusion of ELLs in large-scale testing appears to be based on the premise that testing accommodations ensure valid, fair testing for these students, there is scant evidence in support of such premise. Of the dozens of forms of testing accommodation used by states in large-scale assessment programs (Rivera, Collum, Willner, & Sia, 2006), only a few have been proved to be effective (e.g., the linguistic simplification of test items), but they are only moderately effective in minimizing limited proficiency in the language of testing as a threat to the validity of test scores (e.g., Abedi, Lord, Hofstetter, & Baker, 2001). Randomly assigning ELLs to testing accommodations based on the information typically available on students' English proficiency and not providing them with any testing accommodation at all, does not make any significant difference in test scores (Kopriva, Emick, & Hipolito-Delgado, 2007)—which speaks to how

far we are from being able to assume that the use of most of the currently available forms of testing accommodations ensures valid, fair testing for ELLs.

To a large extent, this limited effectiveness of testing accommodations for ELLs is attributable to the fact that most of them lack adequate theoretical support, are poorly and inconsistently implemented, and are borrowed from the field of special education (see Solano-Flores, 2008).

Defining vignette illustrations

Vignette illustrations can be defined as images added to the text of test items originally created without illustrations, with the intent to make the content of those items accessible to ELLs and without giving away their answers. Because they can be added to test items without altering their text, vignette illustration are a potential cost-effective, form of testing accommodation that, in theory, may be easy to implement.

Figure 1 provides an example of a vignette-illustrated item used by Prosser (2010) in a related investigation that uses cognitive interviews to probe ELLs' interpretations of both illustrated and non-illustrated versions of science items. Unlike the vast majority of illustrated items used in large-scale assessment programs, a vignette-illustrated item has three properties:

1) The illustration provides a simple, concrete representation of one or two of the constituents (components) mentioned in the text of the item. In the example, the constituents represented are, "noticed" and "plate of agar."

2) The text of the item does not refer the test taker to the illustration. There are no directions such as, "Look at the illustration."

3) The text of the item provides all the information needed to understand it and respond to it. Someone proficient in the language of testing is very likely to understand the item without seeing the image.

Alexander Fleming noticed that bacteria growing on a plate of agar did not grow next to a mold that was growing on the same plate. He wrote in his laboratory report: "The mold may be producing a substance that kills bacteria." This statement is best described as

A. an observation
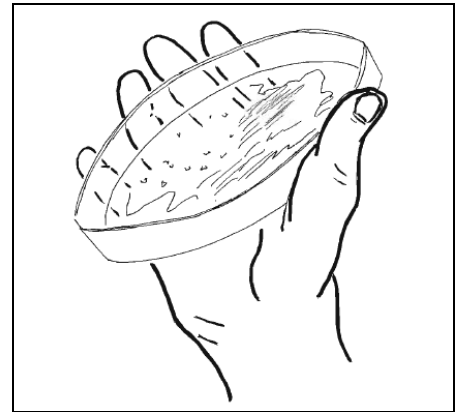B. a hypothesis
C. a generalization
D. a conclusion

Figure 1.
An vignette-illustrated item. The illustration was added. Source*: IEA (1999). TIMSS 1999 Science Items. Released Set for Eighth Grade.* nces.ed.gov/timss/pdf/TIMSS8_Science_Items_1.pdf. Retrieved April 18, 2011.

The notion of vignette illustration emerged accidentally, when we observed that, the percentages of ELL students who responded correctly to mathematics items tended to be higher for items that were accompanied by illustrations than items without illustrations (Solano-Flores, Li, Speroni, Rodriguez, Basterra, & Dovholuk, 2007). Since illustrated items was not the focus of that investigation, we did not have a sufficient number of illustrated items to examine the statistical significance and effect size of any differences observed

between illustrated and non illustrated items. However, the differences were intriguing enough to motivate us to research literature related to this matter.

While test developers are encouraged to use illustrations as a resource for supporting ELLs to gain access to the content of items (Kopriva, 2008; Shorrocks-Taylor, & Hargreaves, 1999), we found that, with very few exceptions, illustrations (of any kind) are a neglected topic in research on testing and no research on illustrated items has been conducted to examine its possibilities in the testing of ELLs. We also found that state and national assessment programs (e.g., NAEP) do not make any provision for the use of illustrations as a form of testing accommodation for ELLs (cf. Rivera & Collum, 2006).

Challenges in the development of illustrations

While the concept of vignette illustration is simple, creating vignette illustrations poses multiple challenges. Four main challenges stand out. The first challenge is conceptual. All sorts of tables, graphs, charts, schematics, maps, figures, and representations of objects (to mention a few) are usually referred to as illustrations. Also, illustrations come in multiple styles, including realistic, schematics, photographic, iconic, emblematic, and cartoon-like. While in some cases several forms of illustrations have been treated as interchangeable (e.g., Shanahan, 2006), it should be recognized that each category—and each case within each of these broad categories—is unique as to the set of cognitive demands and affordances they pose to the viewer/reader.

The second challenge is methodological. Illustrations added to test items should not have too many elements to the extent that the cognitive load of an illustrated item is increased unnecessarily. As semiotic modes, image and text interact and may reinforce each other playing complementary roles (Kress & van Leeuwen, 2001). At the same time, there is an increased cognitive demand that results from imposing an individual to integrate information provided both visually and in textual form (Mayer, 2005).

Sally is swimming in an outdoor pool. She hears thunder. What is the safest thing for Sally to do?

    (A) Stay in the water
    (B) Stand under a tree
    (C) Go into a building
    (D) Dry off and stand by the water

From what you have learned in science, explain why your choice is the safest.
_____
_____
_____
_____

Figure 2.
The Thunder item. Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress. NAEP 2000 Science Assessment Public Released Items for Grade 4. http://nces.ed.gov/nationsreportcard/itmrlsx/search.aspx?subject=science. Retrieved April 18, 2011.

The third challenge is procedural: The content of the illustration should be determined following a set of well established principles. For example, when generating the vignette illustration for the item shown in Figure 2, developers should use a set of reasonings and a

methodology that enables them to decide, in a non-arbitrary manner and based on knowledge of the targeted ELL populations, whether the vignette should show Sally, a swimming pool, or Sally swimming in a pool.

The fourth challenge is practical. Not all developers are illustrators but professional illustrators might not have the knowledge needed to properly determine what an illustration should show. For example, an illustrator might erroneously represent the thunder mentioned in the item as a ray. At the same time, to ensure test security, illustrators may not be allowed to have access to the items. Also, the style and layout of illustrations should not be determined by idiosyncratic factors. Testing programs should need to ensure that different illustrators are consistent in the ways in which they illustrate their items.

To address these four issues, we developed a framework for vignette illustration design and a procedure for developing vignette illustrations.

Framework for Vignette Illustration Design

The framework for vignette illustration design is a tool intended to support developers to reason about the vignette illustrations they need to develop. This framework: (1) postulates the existence of several functions of illustrations; (2) formalizes a set of basic principles for the design of vignette illustrations; (3) and proposes a visual grammar for examining illustrations.

Functions of illustrations in science

From examining samples of released items from TIMSS, NAEP, and several state assessments, and items developed by teachers in their classrooms, we postulate the existence of several functions of images that are relevant to science. These functions are shown in Table 1.

Table 1.
Functions of illustrations in science.

State: condition.
Narration: Succession of events, changes of state, process, procedure.
Metaphorization: Symbolization of meanings, values, or emotions, including humor.
Classification: Taxonomical relationships between subjects/objects.
Analysis: Relationships between components and part-whole relationships.
Instantiation/concretization: An object as an example of an idea or set of cases.
Abstraction: A class of objects.
Conditionality: A cause-effect relationship between objects or events.
Comparison: Similarities or differences between subjects/objects.
Contextualization: Conditions, circumstances, or environment surrounding an object.
Time sequence: Succession of events or stages.
Time compression: Representation of a selected set of events in sequence.
Time expansion: Detailed representation of a sequence of events.
Spatial arrangement: Relative position of objects.
Space compression: Representation of a selected set of objects.
Space expansion: Detailed representation of an arrangement of objects.
Simplification of components: Representation of selected set of objects.
Reminding: Relatedness of content to viewer's episodic experience.

Source: Solano-Flores, G. (2010a). *Vignette illustrations as a form of testing accommodation for English language learners: A design methodology for use in large-scale science assessment.* Paper presented at the Annual Conference of the National Council of Measurement in Education, Denver, Colorado, April 29-May 3.

An important observation that speaks to the conceptual value of this set functions is the fact that we have been able to identify that, often, the functions of illustrations that teachers create for classroom assessment consist of metaphorizations (mainly, humor intended to make the students feel comfortable when they are taking tests) and reminding (e.g., visual clues intended to make students remember a discussion in class, or references to field trips and other experiences). Obviously, these functions are meaningless or usless in the context of large-scale testing.

Also, we have observed that certain functions are common in science textbooks and science tests but are problematic for vignette illustrations. For example, the temporal sequence of events cannot be illustrated properly without making a vignette illustration too complex. Awareness of what can and not be represented with vignette illustrations is part of the knowledge that developers need to have in order to be able to develop effective illustrations.

Visual grammar

We have developed a simple visual grammar intended to provide item illustration developers with a set of rules for writing illustration scripts which describe the content of illustrations. According to this grammar, in developing a vignette-illustration, the illustration developers must determine the appropriate illustration constituent for the item. A grammar constituent is a combination of several of four basic components: subject, object, action, and background. There are six possible illustration constituents that result from the combination of the four illustration components, shown and illustrated in Table 2.

Table 2.
Visual grammar constituents.

Constituent		Example
S.	Subject (no background)	*A cat*
S+b.	Subject (with background)	*A cat in a kitchen*
SA.	Subject performing an action (no background)	*A cat running*
SA+b.	Subject performing an action (with background)	*A cat running in a kitchen*
SAO.	Subject performing an action that affects an object (no background)	*A cat running after a mouse*
SAO+b.	Subject performing an action that affects an object (with background)	*A cat running after a mouse in a kitchen*

Source: Solano-Flores, G. (2010a). *Vignette illustrations as a form of testing accommodation for English language learners: A design methodology for use in large-scale science assessment.* Paper presented at the Annual Conference of the National Council of Measurement in Education, Denver, Colorado, April 29-May 3.

As a part of the procedure, under certain circumstances, test developers need to provide, when applicable, specifications of the illustration components. These specifications, shown in Table 3, are the visual equivalent of adjectives (which modify nouns) and adverbs (which modify adjectives or verbs).

We have observed that some illustrations used in assessment programs can potentially mislead students in their responses or provide clues to the correct option of multiple choice items. Thus, our procedure specifies that the illustrations have to be developed exclusively on

the stems of the items. However, the review of the vignette-illustrated item considers both the stem and the options of the items.

Table 3.
Illustration specifications.

Specification	Example
Subject specifications: Adjective	*an old cat*
Adjective specifications (Mode or extent of the adjective)	*a very old cat*
Action specifications: Mode or extent of the action	*a cat running fast*
Object specifications: Adjective	*a frightened mouse*
Mode or extent of the adjective	*a very frightened mouse*
Background specifications: Adjective	*a run down kitchen*
Mode or extent of the adjective	*a very run down kitchen*
Additional background	*a run down kitchen at night*

Basic principles for vignette illustration design

The basic principles for guiding the design of vignette illustrations are shown in Table 4. They consist of statements that synthesize what developers need to have in mind if they are to develop appropriate visual supports for ELLs,

Table 4.
Basic principles for vignette illustration design.

1) The design of vignette illustrations should target a specific broad linguistic group (e.g., native speakers of Spanish.
2) The content of the illustration should be determined based on identifying constituents (words, phrases, idiomatic expressions) likely to pose a challenge to the ELLs.
3) The constituents (words, phrases, idiomatic expressions) to be illustrated should not be part of the knowledge assessed.
4) To prevent the illustration from being complex or distracting, the illustration should not represent more than one or two constituents.
5) The representation of the constituents illustrated should be accurate.

Procedure for Developing Item Vignette Illustrations

The procedure for developing item vignette illustration establishes the actions and conditions needed to properly develop the vignette illustrations. This procedure: (1) establishes a set of dimensions that testing programs and test developers need to take into consideration for properly standardizing the characteristics of the vignette illustrations used; (2) identifies the professionals that should participate in the process of illustration development; and (3) establishes the steps that need to be taken to develop the vignette illustrations.

Standardization in the design of vignette-illustrated items

We have identified a series of dimensions on the characteristics that all vignette illustrations in a given assessment should have in order to ensure standardization in their design. These dimensions are shown in Table 5. They refer to the characteristics of the illustrations that need to be taken into account so that they can be developed systematically and consistently.

Table 5.
Standardization dimensions relevant to the design of vignette illustrations.

Zooming
Vertical view of the object
Horizontal view of the object
Background
Perspective
Abstractness
Content area register
Visual conventions
Color
Proportion
Shading
Relative scale of objects
Schematic
Use of labels

Altogether, these specifications can be thought of as the "illustration policy" of an assessment program. Needless to say, decisions made regarding these dimensions are determined by diverse factors such as cost (e.g., color vs. black and white), conceptual considerations (e.g., relative scale of objects), and the topics assessed (e.g., zooming out, in the case of maps; zooming in, in the case of microscopic objects). To our knowledge, assessment programs do not have documents that establish the characteristics of the illustrations used in their tests.

As an example of the ways in which these dimensions need to be considered by illustration development teams comes from our project. Regarding zooming, we decided that our illustrations should not represent any objects or situations that were beyond what students could see with the naked eye. This way we attempted to make it more likely for ELL students to relate the content of the illustration to their everyday life experiences, without assuming any familiarity with visual representations whose interpretation might depend on formal instruction (e.g., a representation of an atom, a view of Jupiter with a telescope).

Interdisciplinary teams

As with the process of development of any instrument intended to measure academic achievement (see Solano-Flores & Shavelson, 1997), the process of developing vignette illustrations should be an interdisciplinary, coordinated effort. Table 6 lists the professionals that, based on our experience developing vignette illustrations, should be involved in this process and the kinds of contributions they make. While the scientist and the linguist can participate as consultants at key points during the process of development, the bilingual educators, the science teachers, and the measurement specialist should be involved at all stages of the process of illustration development.

Table 6.
Professionals that should be involved in the process of developing vignette illustrations.

Professional	Contribution
Bilingual educator with experience teaching ELL students of the broad linguistic group targeted	Identifies in the text of the item the constituents (e.g., words, phrases, idiomatic expressions) that are likely to limit ELLs' access to the content of the item due to limited proficiency in English or cultural differences. Identifies in the text of the item the constituents and situations (e.g., contextual information) that are unlikely to pose a challenge for ELLs to gain access to the content of the item and which can be part of the content of the illustration.
Science teacher	Identifies in the text of the item the constituents that should not be illustrated because they are part of the content assessed. Examines the accuracy and adequacy of the illustration. Provides guidance on the resources that the illustrator can use as a reference.
Scientist	Examines the accuracy of the illustration.
Linguist	Supports the team in the process of identifying in the text of the item those constituents that either are challenging to ELLs or are likely to be properly understood by ELLs.
Literacy expert	Provides expertise on the linguistic challenges of the text and assists the team in reasoning about the ways in which image and text interact,
Measurement specialist	Ensures that the illustration does not alter the construct the item is intended to measure. Ensures that the illustration does not give away the content whose knowledge the item is intended to assess. Supports the team in the process of developing the illustration script.
Illustrator with experience in scientific illustration	Develops the illustration according to the script provided by the team of developers and with the categories for standardization established by the project.

Steps in the procedure for developing vignette illustrations

The procedure for developing item illustrations consists of five stages, shown in Table 7. As part of the illustrability analysis stage, with facilitation from project staff, item illustration developers discuss at length the content and linguistic features of an item and examine the illustrability of the language constituents—words, phrases, idiomatic expressions whose presence in the text of the item hamper or facilitate ELLs' access to the item. During the illustrability analysis, developers identify what in the text of the item can and cannot be illustrated and, for those features that can be illustrated, which ones should and should not be included in the illustration in order ensure that the illustration is likely to provide the visual support intended without giving away the response to the item.

From our experience developing the illustrations for our project, we know that the development team takes, on average, about 25 minutes to write the illustration script for the illustrator. In contrast, illustrators may need to prepare several sketches of the illustration before it is approved by the team.

Table 6.
Procedure for developing vignette illustrations.

1. Illustrability analysis
   Item content/key idea terms: Constituents that are part of the knowledge targeted by the item (e.g., "food chain" in an item that assesses knowledge on the content area of ecology).
   Linguistic/cultural challenges: Constituents that are likely to be challenging to ELL students because of their complexity or because students' lack of familiarity with them (e.g., "Which of the following...")
   Linguistic/cultural affordances: Constituents with which ELLs are likely to be familiar and may contribute to the proper interpretation of the item.
   Unillustratable elements: Constituents that cannot be illustrated because they refer to abstract concepts (e.g., "no," "frequently"). In this project, sequences of events are regarded as unillustratable elements because they make illustrations complex and possibly very difficult to interpret.
   Illustratable elements: Constituents that can be illustrated because they are concrete (e.g., "door".
   Undesirable illustratable elements: Constituent that could be illustrated but should not be illustrated because they would direct the students to response to the item (e.g., by giving them a clue to the correct option of an item).
2. Identification of issues that require resolution
   Questions for specialists: Issues that arise from the illustrability analysis and whose resolution requires the expert opinion of specialists.
   Errors found in the original item: Errors in the items identified during the analysis.
3. Scripting
   Writing a detailed description for illustrators of the content of the illustration. This includes the features that should be included and those that should be included.
4. Providing resources for illustrators
   Weblinks (e.g., to Google images or Clip Art) or documents for the illustrators to use to better understand the script.
5. Illustration work
   Iterative process of review and revision in which the illustration proposes drafts of the illustration and the project staff provides feedback, until a version of the illustration is reached which has the desired characteristics.

Summary and Final Remarks

This paper presents a framework and a procedure for developing vignette illustrations as a form of testing accommodation for English language learners (ELLs). The framework provides developers with the reasonings needed to think about the vignette illustrations they need to develop; the procedure establishes the actions and conditions needed to properly develop the vignette illustrations. Soon we will be able to provide empirical evidence on the effectiveness of this form of accommodation. For now, our experience developing the framework and the procedure show the multiple conceptual, theoretical, practical, and methodological aspects that need to be addressed when designing a form of testing accommodation for ELLs. This is a serious endeavor whose complexity should not be underestimated.

In developing our conceptual framework and procedure for developing item vignette illustrations, we have found ourselves in need for formalizing our reasonings about the ways in which they are used in tests. Thus, while this project is about creating a procedure for

systematically *developing* item illustrations, we have had to create, in addition, a procedure for *examining* illustrations. We have created and are currently refining a more comprehensive conceptual framework and a coding system for characterizing illustrations (both vignette illustrations and other forms of illustrations) used in tests (Solano-Flores & Wang, 2011; Wang & Solano-Flores, 2011). We will use this coding system to examine the illustrations generated in our own project. Among other things, the coding system will make it possible for developers and researchers to assess and compare the visual complexity of illustrations used in any form of science illustrated item. This coding tool will allow to compare and assess the quality of illustrations used in different assessment programs.

As we have moved along in this project, it has become evident that we have the big responsibility to avert oversimplification or misuse of this form of vignette illustrations as a form of testing accommodation—which, given its novelty, we believe is likely to happen if awareness of its complexity is not disseminated efficiently. Thus, through disseminating our work among different audiences and through different types of publications, we make the attempt to ensure that potential users, including researchers, practitioners, decision makers, and test developers have a clear idea of the complexity of developing illustrations.

Notes

Note 1. Originally, "Design and Use of Illustrations in Test Items as a Form of Accommodation for English Language Learners in Science and Mathematics Assessment." Following suggestions by the reviewers and the program officer, the project focuses only on science assessment. Because the conceptual framework presented has evolved from previous ideas developed in the last two years, Tables 1, 2, and 5, have been taken, with minor changes, from two previous papers (Solano-Flores, 2010 a, b)

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