

USING DDI 3 FOR COMPARISON



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Using DDI 3 for Comparison

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ABSTRACT

This paper explores how archives can use DDI 3 to support and document data comparison and harmonization. In researching this area, it was necessary to evaluate the comparison options in DDI 3, to understand how they are intended to be used. Another focus was to explore the possibility of building a DDI 3-based tool for comparison and harmonization, taking advantage of the machine-actionability features of the standard.

BACKGROUND

Data analysts frequently make use of sets of related studies. This often requires an understanding of how the studies in the group compare to each other with respect to concepts, universes, questions, and variables. Capturing basic comparison information for the studies in a group is a value-added service that archives could provide. There appear to be a number of options for providing this information using DDI 3, and the approaches should be evaluated in terms of the effort involved in creating the additional DDI 3 content as well as the types of tools that would facilitate both the metadata capture process and the delivery of this new information in a useful format, particularly for harmonization.

The overall question addressed in this use case is how DDI 3 can be used to support and document data comparison and harmonization projects. To do so involved two separate but related tasks:

1. Exploring the use of the Comparative module (information coverage, functionality) and how it relates to using the Inheritance model in Groups as well as Resource Packages for different types of comparison situations.
2. Investigating what a tool to assist in documenting comparability and data harmonization in DDI 3 might look like in terms of features and functionality, possibly based on tools currently used at ICPSR.

Task 1: Comparison Options in DDI 3: Understanding the Comparative Module

To facilitate the first task, DDI 3 markup was applied to the “Adult Demographics” variables of three nationally representative surveys on mental health, integrated in the Collaborative Psychiatric Epidemiology Surveys (CPES), funded by the National Institute on Mental Health. Those surveys are:

- National Comorbidity Survey Replication (NCS-R)
- National Latino and Asian American Study (NLAAS)

- National Survey of American Life (NSAL)

The CPES studies were conducted individually but with comparison in mind. They may be analyzed independently and they did not have a longitudinal design; for all three, the data were collected between 2001 and 2003.

The intent of the CPES project was to enable comparisons across populations, or subpopulations, of the USA. The populations for these studies were:

- NCSR – US national probability sample
- NLAAS – Target populations: Latino and Asian-American
- NSAL – Target populations: African-American and Afro-Caribbean

The CPES project, completed in 2008, was a collaboration between Survey Research Operations (SRO) and the Inter-university Consortium for Political and Social Research (ICPSR), both units of the Institute for Social Research, University of Michigan. SRO generated a harmonized dataset based on the component studies, and ICPSR created Web-based interactive documentation using XML provided by SRO. The XML was loosely based on DDI 2 (supplemented by elements designed to document the data collection instrument). More information on CPES can be found at: <http://www.icpsr.umich.edu/CPES/>.

For purposes of this use case, we created CPES markup that was compliant with DDI 3.0. This markup served as the foundation for investigating how comparison works in DDI 3. Another goal in creating the markup was to attempt to replicate the CPES crosswalk – a table that compares equivalent variables across the component CPES studies – for example, <http://www.icpsr.umich.edu/cocoon/cpes/cpes/BLDEMOGRAP/all/section.xml>. The publicly available crosswalk was built manually. If we could replicate the crosswalk using the DDI 3 markup and XSLT stylesheets, this would in effect be a proof of concept that the markup was effective in documenting comparison.

USE CASE / REQUIREMENTS

Comparability may be documented in DDI 3 using either inheritance in a grouping structure, or the Comparative module. Selecting the most adequate method is one question for this use case. In answering this question it is important to know what the practical implications of using either method are – advantages, disadvantages, and issues related to applying markup and/or processing.

Resource Packages, containing information intended for reuse across studies (for example, occupation code lists), are another useful feature of DDI 3 that may also factor into comparison at different levels.

DDI 3 was designed to document two different kinds of comparison, by design and ad-hoc (often referred to as ex-ante and ex-post comparisons). Studies designed to be compared, like longitudinal or multinational surveys, are developed with the intention of using identical variable structures across multiple iterations of data collection. These types of studies can make use of the inheritance feature in the DDI 3 Group module. Ad-hoc groups, which usually include studies not originally designed to be compared, may be created for comparison purposes, but cannot use the inheritance feature. Table 1 below shows the DDI 3 features that are available to demonstrate comparability and the types of comparison they support.

<u>Group Type / Comparison Situation</u>	DDI 3 Group: Inheritance	DDI 3 Resource Package: Reuse by different studies	DDI 3 Comparative Module: Pairwise mapping of elements
By-Design / Equivalency	Can be used by placing inherited information at a group level to be used by all members of the group	Can be used by any study within a group at any level. Referencing the same item indicates equivalency	Can be used to map each pair of items, noting they are equivalent
By-Design / Non-equivalency	Can be used to document differences with the ID@action attribute, allowing a choice among Add, Update, Delete	NO	Can be used to map each pair and the level of comparability and difference
Ad-Hoc / Equivalency	NO	Can be used by any study within a group at any level. Referencing the same item indicates equivalency	Can be used to map each pair of items, noting they are equivalent
Ad-Hoc / Non-equivalency	NO	NO	Can be used to map each pair and the level of comparability and difference

Table 1: DDI Features by Group Type/Comparison Situation

POSSIBLE SOLUTIONS and DESIGN CHOICES

Longitudinal studies are the most obvious candidates for using the inheritance model, as well as multinational studies that use the same set of (core) questions across countries. The choice between inheritance and use of the Comparative module is less clear-cut in the case of the CPES studies, which were independently designed and conducted, although with comparison in mind. Since the inheritance model may be supplemented with pairwise mappings to capture comparability information, we decided to focus on the Comparative module, which applies to all group types and comparison situations (see Table 1 above).

Using the Comparative Module

This DDI 3 module currently captures comparison mapping of concepts, universes, questions, variables, categories, and code schemes. All but code schemes use the general mapping structure below. All mappings are pairwise and unidirectional from a source item to a target item. Harmonized items will typically be documented as targets when compared to their sources. When no harmonization is involved, the directionality

becomes unimportant, as in this case the relationship only indicates degree of comparison between two individual items.

General Mapping Structure:

- SourceSchemeReference (required)
- TargetSchemeReference (required)
- Correspondence (required)
 - Commonality (required)
 - Difference (required)
 - CommonalityTypeCoded (optional, not repeatable)
 - CommonalityWeight (optional, not repeatable)
 - UserDefinedCorrespondenceProperty (optional, repeatable)
- ItemMap (optional, repeatable)
 - SourceItem (required)
 - TargetItem (required)
 - Correspondence:
 - Commonality (required)
 - Difference (required)
 - CommonalityTypeCoded (optional, not repeatable)
 - CommonalityWeight (optional, not repeatable)
 - UserDefinedCorrespondenceProperty (optional, repeatable)

Note that the first level of comparison is made on the scheme level. This supports comparison of scheme contents as a whole, clarifying the status of items that do not have specific maps, for instance items in one scheme that have no comparable counterparts in the other scheme, etc. Comparison requires explicit statements regarding Commonality and Difference at both the scheme and item level. Structured description options are provided by Commonality Type Coded, Commonality Weight, and User Defined Correspondence Property.

Comparison Elements Used by the Case Study

Both Commonality and Difference are mandatory elements and were therefore used by in the CPES markup for this case study. Of the optional comparison descriptions, Commonality Type Coded seemed both appropriate and sufficient to the use case. Commonality Weight appears best suited for situations in which an objective measure can be made, whereas User Defined Correspondence Property is available for those instances that may not be optimally covered by the other two coded options.

Currently DDI 3 field-level documentation suggests the following values for Commonality Type Coded: "Identical", "High", "Medium", "Low", "None". The element itself is a Code Value Type which allows for the creation of a controlled vocabulary represented in a DDI-defined expression of Genericcode. Our CPES markup made use of a simplified code list – "Identical", "Some", and "None" – proposed by the DDI Controlled Vocabulary Group.

```

<cm:ItemMap> <cm:SourceItem> DA29 </cm:SourceItem>
<cm:TargetItem> DM1_5E </cm:TargetItem>
<cm:Correspondence> <cm:Commonality> CONCEPT, QUESTION, VALUES, VALUE LABELS, UNIVERSE </cm:Commonality>
<cm:Difference> none </cm:Difference>
<cm:CommonalityTypeCoded> IDENTICAL </cm:CommonalityTypeCoded> </cm:Correspondence> </cm:ItemMap>
<cm:ItemMap> <cm:SourceItem> DA30 </cm:SourceItem>
<cm:TargetItem> DM1_5F </cm:TargetItem>
<cm:Correspondence> <cm:Commonality> CONCEPT, QUESTION, VALUES, VALUE LABELS, UNIVERSE </cm:Commonality>
<cm:Difference> none </cm:Difference>
<cm:CommonalityTypeCoded> IDENTICAL </cm:CommonalityTypeCoded> </cm:Correspondence> </cm:ItemMap>

<cm:ItemMap> <cm:SourceItem> DA37 </cm:SourceItem>
<cm:TargetItem> DA37 </cm:TargetItem>
<cm:Correspondence> <cm:Commonality> CONCEPT; VALUES, VALUE LABELS, UNIVERSE </cm:Commonality>
<cm:Difference> QUESTION (wording) </cm:Difference>
<cm:CommonalityTypeCoded> SOME </cm:CommonalityTypeCoded> </cm:Correspondence> </cm:ItemMap>

```

If the list of elements used to document item Commonalities and Differences is structured and used consistently, it may become machine-actionable, eliminating the need for using other fields, like CommonalityWeight or User Defined Correspondence to introduce additional coded lists. Thus, the question arises: Should the specification enforce this through a controlled vocabulary that may be either required (included in the schema) or optional (externally defined)? If such an alternative is considered, it should be noted that a specific list would be needed for each type of map. The elements listed in our markup example are suitable for comparing variables, but not other types of items, like concepts, universes, etc.

Typically, maps only include comparable items. Those that are not comparable will be listed in the Correspondence: Difference sequence under the scheme comparison and/or will be parsed and retrieved directly from the referenced scheme.

RESULTS

Our experience in creating and evaluating CPES markup was instructive. We find that when a harmonized dataset *IS* being produced, once candidate variables for harmonization have been identified, documenting pairwise comparisons between source variables in DDI as an intermediary step (pre-harmonization) appears to be superfluous. Unless reliably automated in some fashion as an aid to the selection process, it does not assist in the decision-making process, which takes a more holistic approach, assessing candidate variables as a group. Documenting comparability at this stage would involve an expense of time and effort that would not be justified by its limited/transitory utility, since the harmonized variable would capture the comparability among sources anyway.

When producing a harmonized dataset, there is greater benefit in using the Comparative module to document similarities and differences between the harmonized variable and each of its sources (post-harmonization) This kind of documentation is required by harmonization best practices, and it is routinely produced even when no

documentation standard is being used. Furthermore, information about the comparability among source variables may be recreated by parsing their pairwise comparison with the harmonized one.

However, if a harmonized dataset is *NOT* being produced, then it is useful to document the comparability of “original” variables to assist secondary data users in their evaluation of variables, and analysis.

Presenting Comparison Results over the Web

As mentioned above, we sought to recreate the CPES variables crosswalk from the pairwise comparisons to confirm the usefulness of the DDI 3 Comparative module. For the purposes of this case study, we used XSLT to render the DDI XML into an HTML display for presentation on the Web. One of the first issues that needed to be addressed was how to pull together comparable variables belonging to multiple studies from the pairwise comparison structure.

Post-harmonization, the identification of “Source” and “Target” is clear: the original variable is the Source and the harmonized variable is the Target.

Source Target

A -> H

B -> H

C -> H

In this case the Target variable is the same in all pairs, and it may be used as an anchor point that pulls together all Sources, making it relatively easy to create the crosswalk and display it.

However, when we are comparing individual, non-harmonized variables for analysis purposes, creating a crosswalk can become very difficult/labor intensive.

Source Target

A -> B

B -> C

A -> C

A -> D

B -> D

C -> D

In this case any of the items can be in either “Source” or “Target” position, and opposite directionality (i.e., B to A, C to B, etc.) needs to be inferred for each pair as the stylesheet needs to support both cases. This results in duplications that need to be cleaned up.

Moreover, in the discrete pairs there is nothing to indicate their relationship to a single group of variables selected for comparison. This makes it difficult to identify sets of related items. A possibility would be to use an attribute like `ItemMap@alias` to create keys for the pairs that need to be linked together. This idea has yet to be tested, but if proven to work, it might greatly facilitate building a crosswalk display.

Despite the difficulties shown above, we were quite satisfied that the crosswalk created through XSLT was similar to the crosswalk displayed on the CPES site, as shown in Figures 1 and 2 below (the crosswalk for our use case did not include the harmonized file) :

NCSR	NLAAS	NSAL
DA27	DM1_5C	compare
DA28	DM1_5D	compare
DA29	DM1_5E	compare
DA30	DM1_5F	compare
DA31	DM1_5G	compare
DA31A	DM1_5H	compare
DA33	DA33	B3
DA35	DA35	compare
DA36_1A1	DA36_1A1	compare
DA36_1A2	DA36_1A2	compare
DA36_3	DA36_5	H49
DA36_3A	DA36_5A	H49A
DA36_3C	DA36_5C	compare
DA37	DA37	compare
DA38	DA38	compare

Figure 1: Crosswalk created for the CPES use case

† This variable appears in different sections of the individual studies.

ID	Label	NCSR	NLAAS	NSAL
V05542	Identify with others of same racial/ethnic descent	DA27	DM1_5C †	
V05543	Feel close in your ideas/feelings w/ ppl of same racial descent	DA28	DM1_5D †	
V05544	Amt time would like to spend w/ ppl of same racial/ethnic grp	DA29	DM1_5E †	
V05545	Importance for same racial/ethnic group to marry within group	DA30	DM1_5F †	
V05546	Citizen of the United States	DA31	DM1_5G †	
V05547	Citizenship in another country	DA31A	DM1_5H †	
V05549	Religious preference:1st mention	DA31B_101		
V05571	Religious preference:2nd mention	DA31B_102		
V05593	Religious preference:3rd mention	DA31B_103		

Figure 2: Crosswalk from the publicly available CPES Interactive Documentation

The problems encountered with using XSLT for creating HTML for the Web highlight the need for using more sophisticated programming approaches for expressing this type of complex information on the Web. Our choice of XSLT was dictated by the small scale of this project as well as the availability of staff and support. However, it was useful in helping identify issues that other users with limited database and programming support would encounter in using a similar type of approach.

ISSUES/RESTRICTIONS

Generating markup is an essential prerequisite in testing the DDI specification. For this project, a limitation was the lack of good tools to automate at least part of this step, but this situation should be remedied during 2010 with the availability of new applications. Another issue encountered was the lack of ready access to programming skills, which appeared necessary given the increased complexity of DDI 3. We had found previous versions of DDI to be fully processible for display by XSLT, so that seemed the most obvious first approach for displaying our documentation on the Web. While we were successful in replicating the CPES crosswalk from a small XML file with a limited number of variables, this exercise also revealed the difficulties that would be encountered in trying to process large instances, documenting entire studies or groups of studies.

OUTLOOK / CONCLUSION

This project helped highlight some of the problems users might run into, as well as the need to build tools to manage different aspects of the standard.

Some of the questions we were able to clarify, as well as some issues that are still being considered, might become part of a Best Practice document for documenting comparability in DDI 3. Here are some examples:

- Possible use of `ItemMap@alias` for anchoring the pairs needing to be linked, to facilitate processing.
- Possible creation of a (suggested) Controlled Vocabulary for listing similar/different elements in the Variable Map.
- Clarification of the specialized usage of `CommonalityWeight` and `UserDefinedCorrespondenceProperty` as well as the fact that they are only intended to be used as needed.
- Even though “None” is part of the Controlled Vocabulary for `CommonalityTypeCoded`, the maps will typically only include items that have some degree of comparability. If an item from a Scheme cannot be compared with any other item in another Scheme, it will be identified by parsing the original scheme against the list generated from the Comparative module.
- When comparing variables, the creation of comparison maps for the individual elements in the variable description is optional and use case-dependent. The Comparative module does not provide links between items included in different maps, and the same item (question, universe, code scheme) may be used by multiple variables that are part of different mappings. The links may be pulled out from the Logical Product, as well as the complete variable descriptions. This has not been tested in practice and should be explored in collaboration with a programmer. An alternative solution would be using a relational database populated with the variables documentation or a Semantic Web store.
- In the Comparative module, documentation of comparability is “dissociated” from the individual variables descriptions. For qualifying studies, the Group + Inheritance model also needs to be tested, to find out whether it would provide a more effective way to capture both variable descriptions and their comparability, while at the same time allowing a complete description of individual datasets, including variables that have no comparable counterparts.

Task 2: Envisioning Tools for Harmonization

Harmonization projects are both complex and labor-intensive, and would greatly benefit from using DDI 3-based tools that would assist by automating at least part of the process, including the creation of documentation.

USE CASE/REQUIREMENTS

In trying to envision such a tool, it was necessary to research a typical harmonization process workflow, to understand the steps involved, and their sequence, and assess where and how DDI 3 and automation might fit in. We took as an example an on-going ICPSR project, the Integrated Fertility Survey Series – IFSS, seeking to produce a harmonized dataset of ten U.S. family and fertility surveys, belonging to three different, but related, series of longitudinal data:

- Growth of American Families, 1955 and 1960
- National Fertility Survey, 1965 and 1970
- National Survey of Family Growth, Cycles I-VI (1973, 1976, 1982, 1988, 1995, and 2002)

These three series were not designed to be compared (although the waves of the individual series were). Details about this project may be found at: <http://www.icpsr.umich.edu/IFSS/>

As mentioned above, the IFSS project was used to understand the steps of the harmonization procedure. After interviewing project staff who were creating the harmonized file, we determined that the workflow steps are roughly as follows:

- Datasets are searched (by keyword or concept, if available).
- Potentially comparable variables are selected.
- Complete variable descriptions are extracted from the existing documentation including:
 - Variable name (and label)
 - Question text / textual description of variable
 - Physical representation (values, value labels, etc.)
 - Universe
 - Question context (preceding questions)
- Similarities and differences in listed elements are examined.
- A harmonized variable is projected based on the findings in the step above (there are no fixed rules; this is done on a case-by-case basis).
- A decision is made regarding the action on the component variables (recode, or simply add).

- Statistical software commands are generated and applied to data to create a new harmonized dataset.
- The harmonized dataset is documented.
- The new variables description includes:
 - Information about source variables.
 - Information about aggregation procedure (recodes, etc.)
 - Information about similarities and differences in source variables compared with the harmonized one (usually in the form of a note).

These steps and their sequence need to be accounted for when planning for a DDI 3 tool to assist in the process.

POSSIBLE SOLUTIONS and DESIGN CHOICES

Desirable Features for a Potential/Projected Tool

A harmonization tool might be built by further developing existing software, while at the same time integrating DDI 3 markup, both as input and as output.

Such a tool would start by searching existing DDI documentation, ideally allowing complex searches (by field, or combinations of fields, Boolean, etc.). It would then allow narrowing down the initial results to a customized selection, and provide same-page display of the selected variables' descriptions, ideally complete with concept and universe statements.

A final selection (including just the variables to be harmonized) could be exported to a different format (spreadsheet, etc.) to facilitate the evaluation of this group of variables, and ultimately develop a translation table.

Alternatively, instead of exporting the search results, the decision process on harmonizing the variables as well as the development of a translation table might take place *within* the tool. In this case, one advantage might be that the recode decisions as captured in the translation table could be converted directly to DDI 3 markup documenting the new, harmonized dataset.

Some of the features listed above are already available in the ICPSR Social Science Variables Database – Internal Search, which is built on DDI 2 markup. DDI 2 documentation is currently uploaded in the database, which may be searched by keyword at variable level. Selections of search results can be exported to an Excel spreadsheet, which is then developed into a translation table, capturing all the necessary information for completing the harmonization and documenting the new dataset. An example of exported search results is shown in Figure 3 below.

A	B	C	D	E	F	G	H
Study Name	Study No	Dataset	Variable	Variable Label	Question Text	Category Label	Category Value
Monitoring the Future: A Continuing Study of American Youth (12th-Grade Survey), 2000	3184	0004	V3453	003E06B:DRG USE+.MY FRND	How about using drugs (other than marijuana or alcohol)-- does that cause a student to be looked up to or looked down on? Among my own group of friends, such drug use is ...]	* DOWN LOT:(1) * DOWN SOM:(2) * NEITHER:(3) * UP SOME:(4) * UP A LOT:(5) * Missing	1 2 3 4 5 -9
Monitoring the Future: A Continuing Study of American Youth (12th-Grade Survey), 2001	3425	0004	V3453	013E06B:DRG USE+.MY FRND	How about using drugs (other than marijuana or alcohol)-- does that cause a student to be looked up to or looked down on? Among my own group of friends, such drug use is ...]	* DOWN LOT:(1) * DOWN SOM:(2) * NEITHER:(3) * UP SOME:(4) * UP A LOT:(5) * MISSING	1 2 3 4 5 -9
Monitoring the Future: A Continuing Study of American Youth (12th-Grade Survey), 2002	3753	0004	V3453	023E06B:DRG USE+.MY FRND	How about using drugs (other than marijuana or alcohol)--does that cause a student to be looked up to or looked down on? B: Among my own group of friends, such drug use is ...]	* DOWN LOT:(1) * DOWN SOM:(2) * NEITHER:(3) * UP SOME:(4) * UP A LOT:(5) * MISSING	1 2 3 4 5 -9
Monitoring the Future: A Continuing Study of American Youth (12th-Grade Survey), 2003	4019	0004	V3453	033E06B:DRG USE+.MY FRND	How about using drugs (other than marijuana or alcohol)--does that cause a student to be looked up to or looked down on? B: Among my own group of friends, such drug use is ...]	* DOWN LOT:(1) * DOWN SOM:(2) * NEITHER:(3) * UP SOME:(4) * UP A LOT:(5) * MISSING	1 2 3 4 5 -9
Monitoring the Future: A Continuing Study of American Youth (12th-Grade Survey), 2004	4264	0004	V3453	043E06B:DRG USE+.MY FRND	How about using drugs (other than marijuana or alcohol)--does that cause a student to be looked up to or looked down on? B: Among my own group of friends, such drug use is ...]	* DOWN LOT:(1) * DOWN SOM:(2) * NEITHER:(3) * UP SOME:(4) * UP A LOT:(5) * MISSING	1 2 3 4 5 -9
Search Criteria - Search Type: Internal Search 1st Keyword: drug use 1st Search Field: all search fields Search Option: and 2nd Keyword: marijuana 2nd Search Field: all search fields							

Figure 3: Selected search results exported to spreadsheet

Such a tool could also incorporate a feature that would automate the production of DDI 3 markup for the Comparative module.

From the selected results list displaying complete variables documentation (if comparing variables among themselves), or from the translation table (if comparing the harmonized variable with its sources), a tool might allow further pairwise selection and offer an interactive feature that would enable the user to flag each pair of elements from the variables description as being “similar” or “different”.

Based on that information, a DDI 3 Comparative module could be created. Elements flagged as similar or different would be listed in the Correspondence:Commonality or Correspondence:Difference fields. The CommonalityTypeCoded element might be filled in an automated way based on the information entered above (all common=“identical”; some different=“some”; completely different = “none”).

OUTLOOK / CONCLUSION

The size and complexity of DDI 3 make it unlikely – and maybe not even desirable – for any single tool to support the entire specification with all its possible use cases.

More limited in scope, and therefore also easier to develop, a comparison/harmonization tool that would assist in documenting comparability and the harmonization process would be a valuable addition to a DDI 3 tool kit that would include a number of smaller applications designed to support different aspects, or parts of the specification.

If working off a database able to ingest both DDI 2 and DDI 3 documentation, such a tool may present the additional advantage of being able to document comparability using DDI 3 even if the individual studies had originally been marked up in DDI 2.

APPENDIX A

The paper is one of several papers which are the outcome of a workshop held at Schloss Dagstuhl - Leibniz Center for Informatics in Wadern, Germany, November 2-6, 2009.

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Wendy Thomas (Minnesota Population Center, University of Minnesota, USA)

Mary Vardigan (Inter-university Consortium for Political and Social Research [ICPSR], University of Michigan, USA)

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APPENDIX B

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