



SMARTERAPP INTERFACE SPECIFICATION for ITEM SCORING CUSTOM OPERATORS

American Institutes for Research

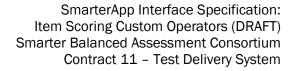
Revision History

Revision Description	Author/Modifier	Date
0.1 - First Draft Release	Jon Cohen Balaji Kodeswaran David Lopez de Quintana	November 17, 2014
0.2 - Added four additional EQ custom operators	Balaji Kodeswaran David Lopez de Quintana	November 19, 2014



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Introduction

Overview

The SmarterApp items are divided into three categories based on how they are scored:

- Not scored: WIT (wordlist item type) and TUT (tutorial) exist as resources to support scored items and so are not intended to be scored. They are not presented to students for scoring, and are not processed by scoring engines. No machine scoring rubrics are provided for these item types.
- 2. Human scored: SA (short answer), ER (extended response) and WER (writing extended response) items are intended to be human scored, so no machine scoring rubrics are provided for these item types.
- 3. Trivially scored: MC (multiple choice) and MS (multi-select) items are scored by comparing a student's response with the "correct" response captured in the item XML itself.
- 4. Machine scored: EBSR (evidence-based selected response), HTQ (hot text QTI) and MI (match interaction) items provide external scoring machine rubric files that are scored using QTI response processing described in an external rubric file.
- 5. Machine scored with custom operators: EQ (equation), GI (grid) and TI (table interaction) item types provide external scoring machine rubric files that are scored using QTI response processing that is extended by custom operators. QTI provides a means of extending default response processing via custom operators as a mechanism.
- 6. Probabilistically scored: ER and WER items containing essays can be scored with an open source essay scoring engine. However, unlike other machine scored items that use a scoring engine to deterministically score any compliant machine rubric, these items require a special machine rubric that is created by "training" the scoring engine with a training set of items that have been previously human scored. This type of item scoring is considered probabilistic as opposed to deterministic because (a) there must be a training process, and (b) the exact scores produced by this type scoring engine for a given student response cannot be predicted based on the contents of a rubric file, but is instead dependent on the training set used and the quality and accuracy of the human scores of the training set.

This document focuses on number 5 above, machine scored items with custom operators. It describes the custom operators used to score EQ, GI and TI item types. General QTI response processing is outside the scope of this document as this is well documented in various QTI standards (see reference 2).

References

	Reference	
1	SmarterApp Assessment Item Format Specifi http://www.smarterapp.org/documents/Sma	cation V0.80 rterApp Assessment Item Format Specification.pdf
2	IMS Question and Test Interoperability v2.1 F http://www.imsglobal.org/question/#version	



CTRL Custom Operators

This section details general custom operators that are not specific to Grid (GI), Table Interaction (TI) and Equation (EQ) Equation item types. All custom operators in this section are of type = CTRL.

mapExpression

Custom Operator	Description	
Function Name	mapExpression	
Function Description	This applies the contained expressions to each element sequentially to each element of the collection identified in "container." All expression must return a Boolean value. Note that the symbol "@" can be used by expressions to reference each element in the set	
Return Type	Container	
Return Description	A container with the same basetype as the input container and an ordered cardinality	

Attributes	Туре	Description
container	Identifier	an identifier bound to a value with cardinality multiple or ordered

stringToFloat

Custom Operator	Description	
Function Name	stringToFloat	
Function Description	Parses a string and converts it to a floating point value	
Return Type	Float	
Return Description	A numerical value based on parsing of the input string, or NaN if the parse fails	

Attributes	Туре	Description
inputString	String	A string formatted as a numerical value

COUNTDOUBLEINRANGE

Custom Operator	Description	
Function Name	COUNTDOUBLEINRANGE	
Function Description	Takes a collection or comma-separated list of numeric values and counts the number of values within the specified range	
Return Type	Integer	





Custom Operator	Description
Return Description	The number of doubles in the specified range

Attributes	Туре	Description
List	String or identifier	either: 1) a list of values consisting of parseable numeric values or numeric variable identifiers prefaced with a "\$", or 2) an identifier bound to a variable with basetype float or integer
Min	Float	minimum value included in the range
Max	Float	maximum value included in the range

COUNTBOOL

Custom Operator	Description	
Function Name	COUNTBOOL	
Function Description	Takes a collection or list of Boolean values and counts the number that are either true or false	
Return Type	Integer	
Return Description	The number of values that are specified	

Attributes	Туре	Description
List	String or identifier	either: 1) a list of values consisting of parseable Boolean values or Boolean identifiers prefaced with a "\$", or 2) an identifier bound to a variable with basetype Boolean
booleanValue	Boolean	true or false. The value to be matched.

MAXINT

Custom Operator	Description	
Function Name	MAXINT	
Function Description	Returns the maximum value of a set of integers	
Return Type	Integer	
Return Description	An integer representing the maximum value in the set if integers provided	



Attributes	Туре	Description
List		either: 1) a list of values consisting of parseable integer values or integer variable identifiers prefaced with a "\$", or 2) an identifier bound to a variable with basetype integer

MININT

Custom Operator	Description	
Function Name	MININT	
Function Description	Returns the minimum of a set of integers	
Return Type	Integer	
Return Description	The minimum value of a set of integer values	

Attributes	Туре	Description
List	string or identifier	either: 1) a list of values consisting of parseable integer values or integer variable identifiers prefaced with a "\$", or 2) an identifier bound to a variable with basetype integer



GRID Item Custom Operators

This section describes the custom operators used in response processing of SmarterApp Grid (GI) item type rubrics. All custom operators in this section are of type = GRAPHIC.

PREPROCESSRESPONSE

Custom Operator	Description	
Function Name	PREPROCESSRESPONSE	
Function Description	Translates graphic responses to a collection of strings representing the objects in the set	
Return Type	basetype	
Return Description	A basetype "string" with cardinality "ordered"	

Attributes	Туре	Description
Response	identifier	names the original XML response to be preprocessed

COUNTSIDES

Custom Operator	Description	
Function Name	COUNTSIDES	
Function Description	Counts the number of line segments that comprise the object	
Return Type	Integer	
Return Description	an integer representing the number of sides of the object. If the object passed in was not graphic object or it was not an object comprised of line segments, zero is returned	

Attributes	Туре	Description
object	identifier	identifier bound to a string representing a graphic object

GETPOINT

Custom Operator	Description
Function Name	GETPOINT
Function Description	Gets a point object corresponding to the location of a point or atomic object in the response space
Return Type	Point





Custom Operator	Description
Return Description	A point in the response space, or null if an inappropriate object was passed in

Attributes	Туре	Description
object	Identifier	Identifier bound to a string representing a point or an atomic object
pointIndex	Integer	The index of the specified point

INTERSECTSREGION

Custom Operator	Description	
Function Name	INTERSECTSREGION	
Function Description	Checks whether an object intersects a rectangular region. For usability reasons intersection is defined as within 5 pixels	
Return Type	Boolean	
Return Description	Boolean indicating whether the object intersected the region	

Attributes	Туре	Description
object	identifier	identifier bound to a string representing a graphic object
topY	Integer	top of the region
leftX	Integer	leftmost part of the region
bottomY	Integer	bottom of the region
rightX	Integer	rightmost part of the region

ISREGIONSELECTED

Custom Operator	Description	
Function Name	ISREGIONSELECTED	
Function Description	Determines if a region is selected	
Return Type	Boolean	
Return Description	Returns true if the region is selected, false otherwise	



Attributes	Туре	Description
region	Identifier	Identifier bound to a string representing a region

GETSELECTEDREGIONSCOUNT

Custom Operator	Description	
Function Name	GETSELECTEDREGIONSCOUNT	
Function Description	Returns the quantity of the regions within a region group that are selected	
Return Type	Integer	
Return Description	The number of selected regions within a region group	

Attributes	Туре	Description
regionGroup	Identifier	Identifier bound to a string representing a region group

GETSLOPE

Custom Operator	Description	
Function Name	GETSLOPE	
Function Description	Calculates the slope of a line	
Return Type	Float	
Return Description	A value representing the slope of the line. Returns NaN if the object is not a line.	

Attributes	Туре	Description
vector	Identifier	Identifier bound to a string representing a line

GETVECTOR

Custom Operator	Description
Function Name	GETVECTOR
Function Description	Returns the index-th vector of a multi-vector object. Vectors are sorted starting with the vector containing the top-most, left-most point, and moving clockwise. Where more than two line segments meet at the same point, the top-most, left-most comes first.
Return Type	String
Return Description	A string representation of the vector





Attributes	Туре	Description
Order	Integer	Index of desired vector
Object	Identifier	Identifier bound to a string representing a graphic object

ISGRAPHICTYPE

Custom Operator	Description	
Function Name	ISGRAPHICTYPE	
Function Description	Determines if the object is a graphic object of the identified type	
Return Type	Boolean	
Return Description	Returns true if the graphic object is an object of the identified type	

Attributes	Туре	Description
Object	identifier	identifier bound to a string representing a graphic object
graphicType	string	must be one of the following: "PALETTEIMAGE", "VECTOR", "ARROW", "POINT"

GETLENGTH

Custom Operator	Description	
Function Name	GETLENGTH	
Function Description	Returns the length of the referenced vector	
Return Type	Float	
Return Description	A value indicating the length of the vector or NaN if anything but a vector is provided	

Attributes	Туре	Description
vector	identifier	Identifier bound to a string representing a vector.

GETNAME

Custom Operator	Description
Function Name	GETNAME





Custom Operator	Description
Function Description	Returns the name of a named graphic object
Return Type	String
Return Description	The name of the graphic object or an empty string if the graphic object is unnamed

Attributes	Туре	Description
Object	Identifier	Identifier bound to a string representing a graphic object

INTERSECTSPOINT

Custom Operator	Description	
Function Name	INTERSECTSPOINT	
Function Description	Determines if the object intersects the designated point	
Return Type	Boolean	
Return Description	Returns true if the object intersects the designated point, false otherwise	

Attributes	Туре	Description
Object	Identifier	Identifier bound to a string representing a graphic object
Х	Integer	x coordinate of the point to check the intersection against
Y	Integer	y coordinate of the point to check the intersection against
Tolerance	Float	Allowable distance from the point still considered intersecting in the same units used in the coordinate plane of the item

HASVERTEX

Custom Operator	Description	
Function Name	HASVERTEX	
Function Description	Determines if a point is among the vertices of an object	
Return Type	Boolean	
Return Description	Returns true if the point (x,y) is among the vertices of the object, false otherwise	

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Attributes	Туре	Description
object	identifier	identifier bound to a string representing a graphic object
tolerance	float	allowable distance from the point still considered intersecting in the same units used in the coordinate plane of the item



TABLE Item Custom Operators

This section describes the custom operators used in response processing of SmarterApp Table Interaction (TI) item type rubrics. All custom operators in this section are of type = TABLE.

GETCOLUMN

Custom Operator	Description
Function Name	GETCOLUMN
Function Description	Obtains the requested column
Return Type	String
Return Description	A string representing the requested column. The string may be empty

Attributes	Туре	Description
table	Identifier	identifier bound to a string representing a table
columnName	String	the name of the desired column

GETHEADERROW

Custom Operator	Description
Function Name	GETHEADERROW
Function Description	Obtains the header row of the table
Return Type	String
Return Description	A string representing the requested header row. The string may be empty

Attributes	Туре	Description
table	identifier	identifier bound to a string representing a table

GETVALUENUMERIC

Custom Operator	Description	
Function Name	GETVALUENUMERIC	
Function Description	Obtains the numeric value of the indicated cell	



Custom Operator	Description
Return Type	Float
Return Description	The numeric value of the indicated cell or NaN if the value cannot be successfully parsed

Attributes	Туре	Description
tableVector	Identifier	identifier bound to a string representing a table
index	Integer	the index of the desired cell



EQUATION Item Custom Operators

This section describes the custom operators used in response processing of SmarterApp Equation (EQ) item type rubrics. All custom operators in this section are of type = EQ.

PREPROCESSRESPONSE

Custom Operator	Description
Function Name	PREPROCESSRESPONSE
Function Description	Translates equation responses to a collection of strings representing the objects in the set
Return Type	Basetype
Return Description	A basetype "string" with cardinality "ordered"

Attributes	Туре	Description
Response	identifier	names the original XML response to be preprocessed

ISEQUIVALENT

Custom Operator	Description
Function Name	ISEQUIVALENT
Function Description	Compares the equation expression to an exemplar and determines if they are equivalent
Return Type	Boolean
Return Description	Returns true if the equation referenced by object is equivalent to the exemplar

Attributes	Туре	Description
Object	Identifier	identifier referencing a string representing a mathematical expression
exemplar	String	string representing a mathematical expression of an exemplar
simplify	Boolean	Flag indicating that simplifications can be performed (e.g. 1+1=2)

ISEQUIVALENTLOG

Custom Operator	Description
Function Name	ISEQUIVALENTLOG





Custom Operator	Description	
Function Description	Compares the equation expression to an exemplar and determines if they are equivalent using properties of Logs	
Return Type	Boolean	
Return Description	Returns true if math expression object is equivalent to exemplar expression using properties of Logs	

Attributes	Туре	Description
Object	identifier	identifier referencing a string representing a mathematical expression
exemplar	string	string representing a mathematical expression of an exemplar
assumptions	Boolean	Flag indicating that bases are positive and exponents are real

ISEQUIVALENTTRIG

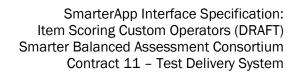
Custom Operator	Description	
Function Name	ISEQUIVALENTTRIG	
Function Description	Compares the equation expression to an exemplar and determines if they are equivalent using Trig identities	
Return Type	Boolean	
Return Description	Returns true if math expression object is equivalent to exemplar expression using Trig identities	

Attributes	Туре	Description
object	Identifier	identifier referencing a string representing a mathematical expression
exemplar	String	string representing a mathematical expression of an exemplar

ISEMPTY

Custom Operator	Description	
Function Name	ISEMPTY	
Function Description	Determines if a math expression is empty	
Return Type	Boolean	
Return Description	Returns true if math expression object is empty	

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Attributes	Туре	Description
object	identifier	identifier referencing a string representing a mathematical expression

NUMBERFROMEXPRESSION

Custom Operator	Description	
Function Name	NUMBERFROMEXPRESSION	
Function Description	Converts the math expression object to a number	
Return Type	double	
Return Description	Returns the numerical value represented by the math expression or Double.NaN if the expression cannot be parsed	

Attributes	Туре	Description
object	Inentitier	identifier referencing a string representing a mathematical expression whose value is of interest

GETINEQUALITIESCOUNT

Custom Operator	Description	
Function Name	GETINEQUALITIESCOUNT	
Function Description	Determines the number of inequalities in a math expression	
Return Type	Integer	
Return Description	Returns the number of inequalities in a math expression object	

Attributes	Туре	Description
object	identifier	identifier referencing a string representing a mathematical expression

ISMATCH

Custom Operator	Description	
Function Name	ISMATCH	
Function Description	Determines if an expression can be matched to a parameterized pattern	
Return Type	Boolean	
Return Description	Returns true if expression can be matched by the given parameterized pattern	





Attributes	Туре	Description
object	identifier	identifier referencing a string representing an expression to be matched to a given pattern
pattern	string	A string representing a mathematical expression
parameters	string	Comma-separated parameters in the pattern (e.g. a,b,c)
constraints	string	Comma-separated constraints on parameter values (e.g. a>=1 and a<4, b==1 or b==2, c!=0)
variables	string	Comma-separated variables in the pattern (e.g. x,t)
simplify	Boolean	Flag indicating that simplifications can be performed (e.g. 1+1=2)

LINECONTAINS

Custom Operator	Description	
Function Name	LINECONTAINS	
Function Description	Returns true if line contains an expression equivalent to exemplar expression. For ex, LineContains(8+8+8=24-2=2, 24-2=22) would return true.	
Return Type	Boolean	
Return Description	True/False	

Attributes	Туре	Description
object	identifier	identifier referencing a string representing a mathematical expression
Exemplar	String	string representing a mathematical expression of an exemplar
Simplify	Boolean	Flag indicating that simplifications can be performed (e.g. 1+1=2)

EXPRESSIONCONTAINS

Custom Operator	Description	
Function Name	EXPRESSIONCONTAINS	
Function Description	Determines if a given math expression object contains a given substring	
Return Type	Boolean	
Return Description	Returns true if the substring is found in the given math expression	

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Attributes	Туре	Description
object	identifier	Identifier referencing a string representing a mathematical expression
string	String	Substring that we are looking for

EVALUATE

Custom Operator	Description	
Function Name	EVALUATE	
Function Description	Converts expression to floating-point approximation (decimal number)	
Return Type	Float	
Return Description	A decimal number that represents the expression or Double.NaN if it cannot be parsed.	

Attributes	Туре	Description
object	identifier	identifier referencing a string representing a mathematical expression

GETEQUATIONSCOUNT

Custom Operator	Description	
Function Name	GETEQUATIONSCOUNT	
Function Description	Determines the number of equations in a math expression object	
Return Type	Integer	
Return Description	An integer count of the equations in the input math expression object	

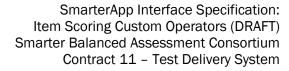
Attributes	Туре	Description
object	identifier	identifier referencing a string representing a mathematical expression



Example Grid Rubric (Type = GRAPHIC)

This section provides an example of a SmarterApp Grid item rubric that contains CTRL and GRAPHIC custom operators.

```
<?xml version="1.0" encoding="utf-8"?>
<AssessmentItem xmlns="http://www.imsglobal.org/xsd/imsqti v2p1">
  <outcomeDeclaration baseType="integer" cardinality="single" identifier="SCORE">
    <defaultValue>
      <value>0</value>
    </defaultValue>
  </outcomeDeclaration>
  <responseDeclaration baseType="string" cardinality="single" identifier="RESPONSE" />
  <outcomeDeclaration baseType="string" cardinality="ordered" identifier="PP RESPONSE" />
  <outcomeDeclaration identifier="a2" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="a2FirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="e2" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="b3" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="b3FirstObject" baseType="string" cardinality="single" />
<outcomeDeclaration identifier="f3" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="c2" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="c2FirstObject" baseType="string" cardinality="single" />
<outcomeDeclaration identifier="g2" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="d5" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="d5FirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="h5" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="cbool" baseType="integer" cardinality="single" />
  <outcomeDeclaration identifier="a0" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="a0FirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="e0" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="a1" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="alFirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="el" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="a3" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="a3FirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="e3" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="a4" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="a4FirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="e4" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="a5" baseType="string" cardinality="ordered" />
<outcomeDeclaration identifier="a5FirstObject" baseType="string" cardinality="single" />
<outcomeDeclaration identifier="e5" baseType="boolean" cardinality="single" />
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  <outcomeDeclaration identifier="a6FirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="e6" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="a7" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="a7FirstObject" baseType="string" cardinality="single" />
<outcomeDeclaration identifier="e7" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="a8" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="a8FirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="e8" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="a9" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="a9FirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="e9" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="b0" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="b0FirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="f0" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="b1" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="b1FirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="f1" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="b2" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="b2FirstObject" baseType="string" cardinality="single" />
  <outcomeDeclaration identifier="f2" baseType="boolean" cardinality="single" />
  <outcomeDeclaration identifier="b4" baseType="string" cardinality="ordered" />
```

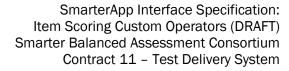




```
<outcomeDeclaration identifier="b4FirstObject" baseType="string" cardinality="single" />
<outcomeDeclaration identifier="f4" baseType="boolean" cardinality="single" />
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<outcomeDeclaration identifier="c4FirstObject" baseType="string" cardinality="single" />
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<outcomeDeclaration identifier="c5FirstObject" baseType="string" cardinality="single" />
<outcomeDeclaration identifier="g5" baseType="boolean" cardinality="single" />
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<outcomeDeclaration identifier="c6FirstObject" baseType="string" cardinality="single" />
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<outcomeDeclaration identifier="d4" baseType="string" cardinality="ordered" />
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<outcomeDeclaration identifier="h4" baseType="boolean" cardinality="single" />
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<outcomeDeclaration identifier="d7FirstObject" baseType="string" cardinality="single" />
<outcomeDeclaration identifier="h7" baseType="boolean" cardinality="single" />
<outcomeDeclaration identifier="d8" baseType="string" cardinality="ordered" />
<outcomeDeclaration identifier="d8FirstObject" baseType="string" cardinality="single" />
```



```
<outcomeDeclaration identifier="h8" baseType="boolean" cardinality="single" />
<outcomeDeclaration identifier="d9" baseType="string" cardinality="ordered" />
<outcomeDeclaration identifier="d9FirstObject" baseType="string" cardinality="single" />
<outcomeDeclaration identifier="h9" baseType="boolean" cardinality="single" />
<outcomeDeclaration identifier="wbool" baseType="integer" cardinality="single" />
<responseProcessing>
  <setOutcomeValue identifier="PP RESPONSE">
   <customOperator type="GRAPHIC" functionName="PREPROCESSRESPONSE" response="RESPONSE" />
 </setOutcomeValue>
 <setOutcomeValue identifier="a2">
   <customOperator type="CTRL" functionName="mapExpression" container="PP RESPONSE">
     <stringMatch caseSensitive="True">
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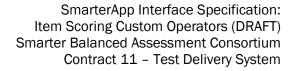




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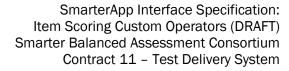


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     </index>
   </setOutcomeValue>
    <setOutcomeValue identifier="h8">
     <customOperator type="GRAPHIC" functionName="ISREGIONSELECTED" region="d8FirstObject" />
   </setOutcomeValue>
   <setOutcomeValue identifier="d9">
     <customOperator type="CTRL" functionName="mapExpression" container="PP RESPONSE">
       <stringMatch caseSensitive="True">
         <baseValue baseType="string">d9</baseValue>
          <customOperator type="GRAPHIC" functionName="GETNAME" object="@" />
       </stringMatch>
     </customOperator>
    </setOutcomeValue>
    <setOutcomeValue identifier="d9FirstObject">
     <index n="1">
       <variable identifier="d9" />
     </index>
   </setOutcomeValue>
   <setOutcomeValue identifier="h9">
      <customOperator type="GRAPHIC" functionName="ISREGIONSELECTED" region="d9FirstObject" />
   </setOutcomeValue>
   <setOutcomeValue identifier="wbool">
     <customOperator type="CTRL" functionName="COUNTBOOL"</pre>
list="$e0,$e1,$e3,$e4,$e5,$e6,$e7,$e8,$e9,$f0,$f1,$f2,$f4,$f5,$f6,$f7,$f8,$f9,$q0,$q1,$q3,$q4,$q5
,$g6,$g7,$g8,$g9,$h0,$h1,$h2,$h3,$h4,$h6,$h7,$h8,$h9" booleanValue="True" />
    </setOutcomeValue>
   <responseCondition>
      <responseIf>
        <and>
          <equal>
            <variable identifier="cbool" />
           <baseValue baseType="integer">4</baseValue>
            <variable identifier="wbool" />
            <baseValue baseType="integer">0</baseValue>
         </equal>
        </and>
```





Example Equation Rubric (Type = EQ)

This section provides an example of a SmarterApp Grid item rubric that contains CTRL and EQ custom operators.

```
<AssessmentItem xmlns="http://www.imsqlobal.org/xsd/imsqti v2p1">
  <outcomeDeclaration baseType="integer" cardinality="single" identifier="SCORE">
     <value>0</value>
   </defaultValue>
  </outcomeDeclaration>
  <responseDeclaration baseType="string" cardinality="single" identifier="RESPONSE" />
  <outcomeDeclaration baseType="string" cardinality="ordered" identifier="PP RESPONSE" />
  <outcomeDeclaration identifier="obj1" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="obj1Count" baseType="integer" cardinality="single" />
  <outcomeDeclaration identifier="obj" baseType="string" cardinality="ordered" />
  <outcomeDeclaration identifier="objCount" baseType="integer" cardinality="single" />
  <responseProcessing>
   <setOutcomeValue identifier="PP RESPONSE">
      <customOperator type="EQ" functionName="PREPROCESSRESPONSE" response="RESPONSE" />
   </setOutcomeValue>
   <setOutcomeValue identifier="obj1">
      <customOperator type="CTRL" functionName="mapExpression" container="PP RESPONSE">
        <customOperator type="EQ" functionName="ISEQUIVALENT" object="@" exemplar="4960/32"</pre>
simplify="False" />
      </customOperator>
   </setOutcomeValue>
   <setOutcomeValue identifier="obj1Count">
     <containerSize>
       <variable identifier="obj1" />
     </containerSize>
   </setOutcomeValue>
    <setOutcomeValue identifier="obj">
      <customOperator type="CTRL" functionName="mapExpression" container="PP RESPONSE">
       <customOperator type="EQ" functionName="ISEQUIVALENT" object="@" exemplar="155"</pre>
simplify="True" />
      </customOperator>
    </setOutcomeValue>
   <setOutcomeValue identifier="objCount">
     <containerSize>
       <variable identifier="obj" />
     </containerSize>
   </setOutcomeValue>
   <responseCondition>
      <responseIf>
        <and>
            <variable identifier="obj1Count" />
           <baseValue baseType="integer">0</baseValue>
          </equal>
            <variable identifier="objCount" />
           <baseValue baseType="integer">1</baseValue>
          </equal>
        </and>
        <setOutcomeValue identifier="SCORE">
          <baseValue baseType="integer">1</baseValue>
        </setOutcomeValue>
      </responseIf>
   </responseCondition>
  </responseProcessing>
</AssessmentItem>
```