

Evaluating Sustainability Competencies through Green Infrastructure Design

Daniel Cronan
University of Idaho
GIS Day, November 15, 2017

The purpose:

To provide a systematic approach for evaluating student learning within a LANDSCAPE ARCHITECTURE STUDIO with **two forms of evidence of learning**:

SELF-REPORTED EVIDENCE

Questionnaires

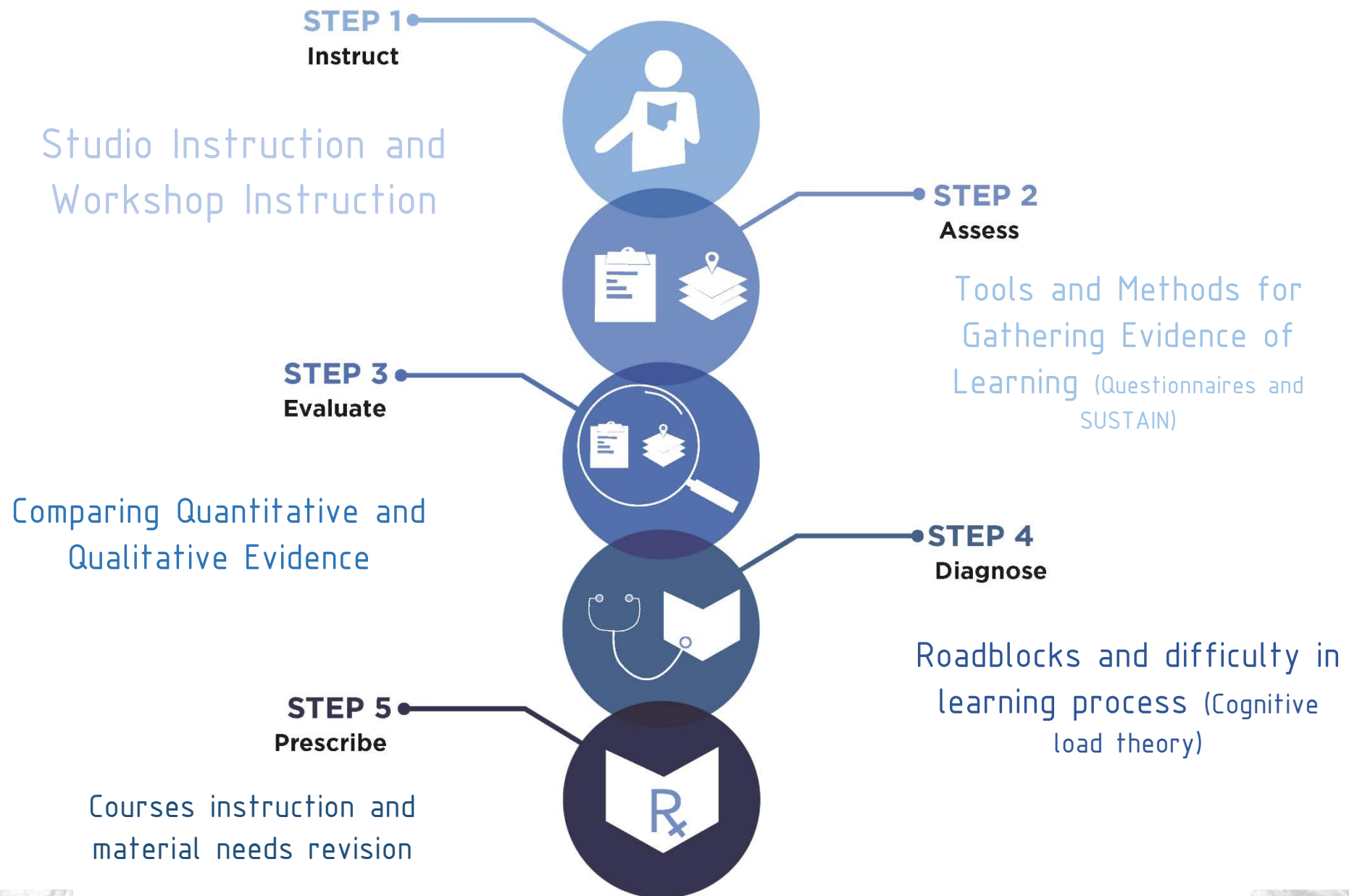
SPATIALLY EXPLICIT EVIDENCE

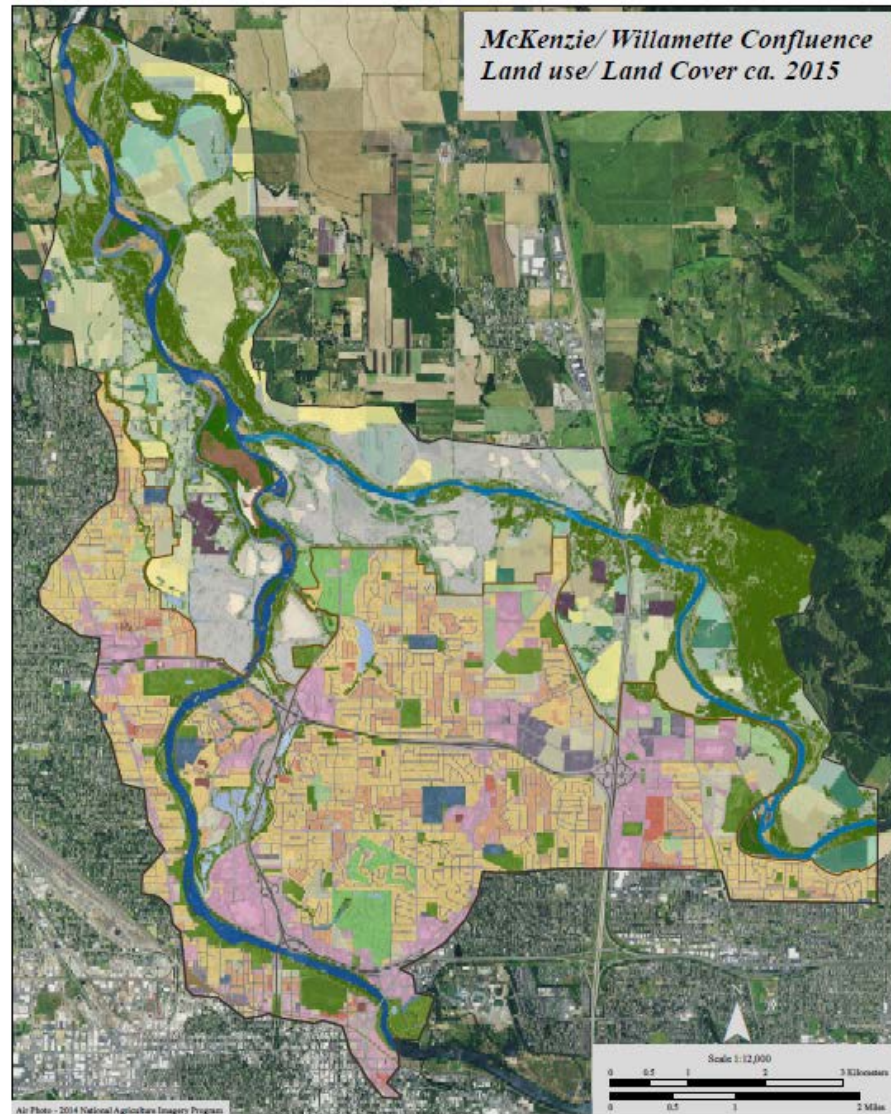
Designs via GIS

This approach may provide educators (including myself) with guidance for developing instructional courses to aid student learning.



Daniel Cronan
University of Idaho
GIS Day, November 15, 2017





**Land Use/
Land Cover
Representation.**
The representation depicts the land use and land cover representation model that was used for both the Studio and the Workshop.



2.3 Site Suitability Criteria

Table 2-4 shows a site suitability criteria matrix and is populated with default criteria that you can change to your preference or local knowledge. The default criteria in the tool are derived from two EPA reports (USEPA 2004a, 2004b). You can modify these criteria using the Siting Tool interface.

Table 2-4. Default criteria for BMP suitable locations used in BMP Siting Tool

BMP type	Drainage area (acre)	Drainage slope (%)	Impervious (%)	Hydrologic soil group	Water table depth (ft)	Road buffer (ft)	Stream buffer (ft)	Building buffer (ft)
Bioretention	< 2	< 5%	> 0%	A–D	> 2	< 100	> 100	--
Cistern	--	--	--	--	--	--	--	< 30
Constructed Wetland	> 25	< 15%	> 0%	A–D	> 4	--	> 100	--
Dry Pond	> 10	< 15%	> 0%	A–D	> 4	--	> 100	--
Grassed Swale	< 5	< 4%	> 0%	A–D	> 2	< 100	--	--
Green Roof	--	--	--	--	--	--	--	--
Infiltration Basin	< 10	< 15%	> 0%	A–B	> 4	--	> 100	--
Infiltration Trench	< 5	< 15%	> 0%	A–B	> 4	--	> 100	--
Porous Pavement	< 3	< 1%	> 0%	A–B	> 2	--	--	--
Rain Barrel	--	--	--	--	--	--	--	< 30
Sand Filter (non-surface)	< 2	< 10%	> 0%	A–D	> 2	--	> 100	--
Sand Filter (surface)	< 10	< 10%	> 0%	A–D	> 2	--	> 100	--
Vegetated Filterstrip	--	< 10%	> 0%	A–D	> 2	< 100	--	--
Wet Pond	> 25	< 15%	> 0%	A–D	> 4	--	> 100	--

Step 1
Instruct



Daniel Cronan
University of Idaho
GIS Day, November 15, 2017

1. Slope: reclassify

Reclassify

Input raster
slope_i

Reclass field
VALUE

Reclassification

Old values	New values
0 - 8	1
8 - 15	1
15 - 52	0
52 - 127	0
127 - 750	0
NoData	NoData

Classify...
Unique
Add Entry
Delete Entries

Load... Save... Reverse New Values Precision...

Output raster
G:\a494_16\dc\crs_gds\slope_re

☐ Change missing values to NoData (optional)

a) reclassify to a binary map $\leq 15\% = 1$, $>15\% = 0$
b) Specify and note output name: e.g. slope_re



c) slope output binary map

2. Depth to Bedrock: reclassify: ≥ 60 inches

Create a binary map of depth to bedrock for the study area.

≥ 60 inches = 1, <60 inches = 0

Reclassify

Input raster
soil_bedr

Reclass field
DEPTH

Reclassification

Old values	New values
Zero inches	0
10 - 20 inches	0
20 - 40 inches	0
40 - 60 inches	0
≥ 60 inches	1
NoData	NoData

Classify...
Unique
Add Entry
Delete Entries

Load... Save... Reverse New Values Precision...

Output raster
G:\a494_16\dc\crs_gds\brock_r

☐ Change missing values to NoData (optional)

a) reclassify tool -change new values to 0 and ≥ 60 inches to 1
b) set output raster name



*depth to bedrock-
output example

Step 1
Instruct



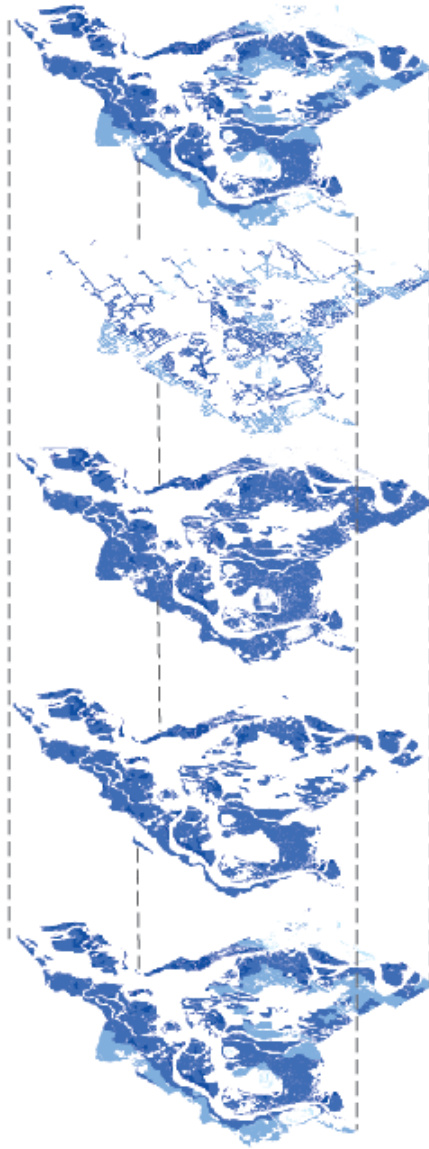
Daniel Cronan
University of Idaho
GIS Day, November 15, 2017

Step 1
Instruct



Daniel Cronan
University of Idaho
GIS Day, November 15, 2017

Step 1
Instruct



wet pond
dry pond
constructed wetland

vegetated filterstrip
grassed swale
bioretention

sandfilter nonsurface

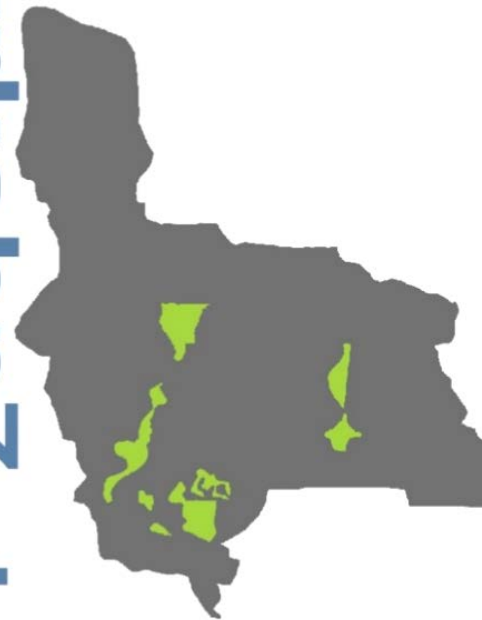
infiltration trench

vegetated filterstrip

Initial Design
(beginning of course)

wrkshp7 - Initial

847 acres
proposed for stormwater
infiltration



Final Design
(end of course)

wrkshp7 - Final

268 acres
proposed for stormwater
infiltration



Daniel Cronan
University of Idaho
GIS Day, November 15, 2017

STEP 2) ASSESS:

GATHERING EVIDENCE OF LEARNING BY RELEVANT FACTOR:

Questionnaires and GIS tools addressing the following factors:

SYSTEM FACTORS:

- 1) Terrain
- 2) Impervious Cover
- 3) Land Use

RUNOFF FACTORS:

- 4) Reduction and mitigation of Runoff

FLOODING FACTORS:

- 5) Flooding and Design Storms

Step 2
Assess



Daniel Cronan
University of Idaho
GIS Day, November 15, 2017

2.3 Site Suitability Criteria

Table 2-4 shows a site suitability criteria matrix and is populated with default criteria that you can change to your preference or local knowledge. The default criteria in the tool are derived from two EPA reports (USEPA 2004a, 2004b). You can modify these criteria using the Siting Tool interface.

Table 2-4. Default criteria for BMP suitable locations used in BMP Siting Tool

BMP type	Drainage area (acre)	Drainage slope (%)	Impervious (%)	Hydrologic soil group	Water table depth (ft)	Road buffer (ft)	Stream buffer (ft)	Building buffer (ft)
Bioretention	< 2	< 5%	> 0%	A-D	> 2	< 100	> 100	--
Cistern	--	--	--	--	--	--	--	< 30
Constructed Wetland	> 25	< 15%	> 0%	A-D	> 4	--	> 100	--
Dry Pond	> 10	< 15%	> 0%	A-D	> 4	--	> 100	--
Grassed Swale	< 5	< 4%	> 0%	A-D	> 2	< 100	--	--
Green Roof	--	--	--	--	--	--	--	--
Infiltration Basin	< 10	< 15%	> 0%	A-B	> 4	--	> 100	--
Infiltration Trench	< 5	< 15%	> 0%	A-B	> 4	--	> 100	--
Porous Pavement	< 3	< 1%	> 0%	A-B	> 2	--	--	--
Rain Barrel	--	--	--	--	--	--	--	< 30
Sand Filter (non-surface)	< 2	< 10%	> 0%	A-D	> 2	--	> 100	--
Sand Filter (surface)	< 10	< 10%	> 0%	A-D	> 2	--	> 100	--
Vegetated Filterstrip	--	< 10%	> 0%	A-D	> 2	< 100	--	--
Wet Pond	> 25	< 15%	> 0%	A-D	> 4	--	> 100	--

Data Management

You may use the right browse buttons to browse and select the data. All layers are optional but at least one layer is required to run the siting tool. Note that all data layers must be in the same projection (linear map units).

Select Raster Data

Elevation grid: Elevation units:

Land use grid: Land use lookup table:

Percent impervious grid:

Select Vector Data

Stream shapefile: Road shapefile:

Urban land use shapefile: Groundwater depth shapefile:

Soil shapefile: Soil lookup table:

Land ownership shapefile:

BMP Siting Criteria

Select BMP Type:

BMP Footprint Siting Criteria

Drainage Area (ac): ☒

Slope (%): ☒

Imperviousness (%): ☒

Hydrologic Soil Groups: ☒

Watertable Depth (ft): ☒

Road Buffer (ft): ☒

Stream Buffer (ft): ☒

Building Buffer (ft): ☐

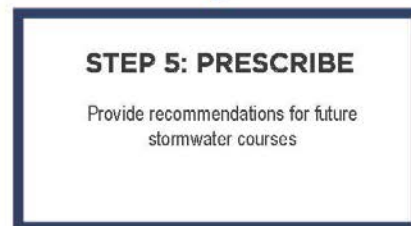
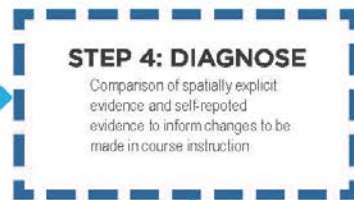
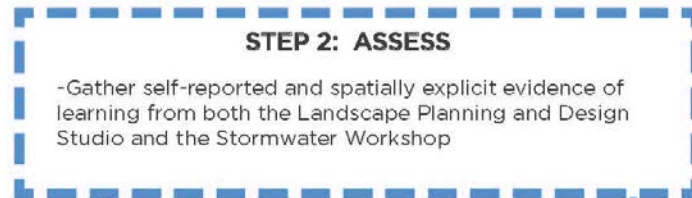
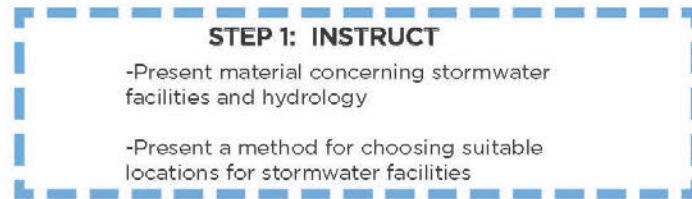
Land Ownership: ☐

Land Use Suitability: ☒

Step 2
Assess



Daniel Cronan
University of Idaho
GIS Day, November 15, 2017



Step 3
Evaluate



Student 7
Initial Design
(beginning of course)

wrkshp7 - Initial

847 acres
proposed for stormwater
infiltration



BEST MANAGMENT PRACTICES (BMPs) Evaluated by SUSTAIN	Percent suitable
constructed wetland 336.5 acres proposed/ 847 total acres	majority of suitable acreage / proposed = 40%
dry pond 336.5 acres proposed/ 847 total acres	majority of suitable acreage / proposed = 40%
wet pond 336.5 acres proposed/ 847 total acres	majority of suitable acreage / proposed = 40%
sand filter(surface) 311 acres proposed/ 847 total acres	majority of suitable acreage / proposed = 37%
infiltration basin 336 acres proposed/ 847 total acres	majority of suitable acreage / proposed = 40%

Average = 34%

Student 7
Final Design
(after course)

wrkshp7 - Final

268 acres
proposed for stormwater
infiltration



BEST MANAGMENT PRACTICES (BMPs) Evaluated by SUSTAIN	Percent suitable
constructed wetland 197 acres proposed/ 268 total acres	majority of suitable acreage / proposed = 73.5%
dry pond 197 acres proposed/ 268 total acres	majority of suitable acreage / proposed = 73.5%
wet pond 197 acres proposed/ 268 total acres	majority of suitable acreage / proposed = 73.5%
sand filter(surface) 194.5 acres proposed/ 268 total acres	majority of suitable acreage / proposed = 72.5%
infiltration basin 197 acres proposed/ 268 total acres	majority of suitable acreage / proposed = 73.5%

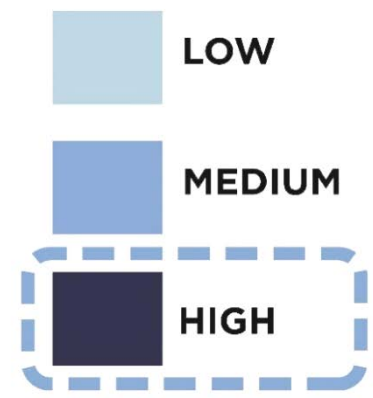
Average = 62%

Design
Algorithm:

BMPs improved

if < 2 improved =LOW
2-3 improved = MEDIUM
>4 improved = HIGH

5 improved = HIGH



Step 3
Evaluate



WORKSHOP							
	Self-Reported			Spatially Explicit			Learning
	positive change	no change	negative	pos.	no change	negative	
student 1	3 factors improved			5 BMPs improved			Medium to High
student 2	5 factors improved			4 BMPs improved			Medium to High
student 3	1 factor improved			4 BMPs improved			Low to Medium
student 4	5 factors improved			5 BMPs improved			High
student 5	5 factors improved			5 BMPs improved			High
student 6	4 factors improved			5 BMPs improved			Medium to High
student 7	4 factors improved			5 BMPs improved			Medium to High

High

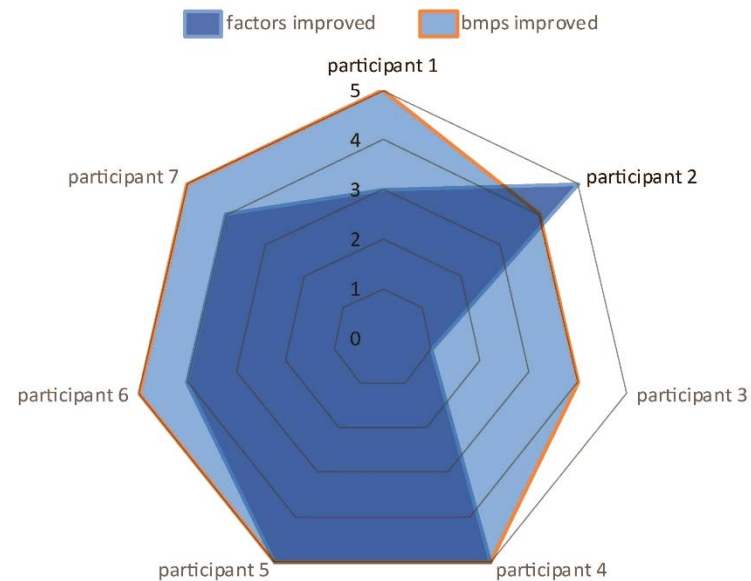
Medium to High

Medium

Low to Medium

Low

Workshop Results



Step 3 Evaluate



Daniel Cronan
University of Idaho
GIS Day, November 15, 2017

DIAGNOSIS:

a) INTRINSIC LOAD:

too much information + not enough time
= too little processing

b) EXTRANEEOUS LOAD:

the material was not activated adequately
within an exercise

c) GERMANE LOAD:

a method of organization was not
presented to Student 7



Step 4
Diagnose



Daniel Cronan
University of Idaho
GIS Day, November 15, 2017

DIAGNOSIS:

a) INTRINSIC LOAD:

too much information + not enough time
= too little processing

b) EXTRANEOUS LOAD:

the material was not activated adequately
within an exercise

c) GERMANE LOAD:

a method of organization was not
presented to Student 7

PRESCRIBE:

a) REDUCE INTRINSIC LOAD

-Adding discussion topics and a particular case study focused solely around reduction of runoff
-an exercise to be completed on Student 7's own time

b) REDUCE EXTRANEOUS LOAD:

an exercise using the EPA's stormwater calculator to show the benefits of using stormwater facilities to reduce runoff

c) REDUCE GERMANE LOAD:

an exercise to explain a method for runoff reduction

