



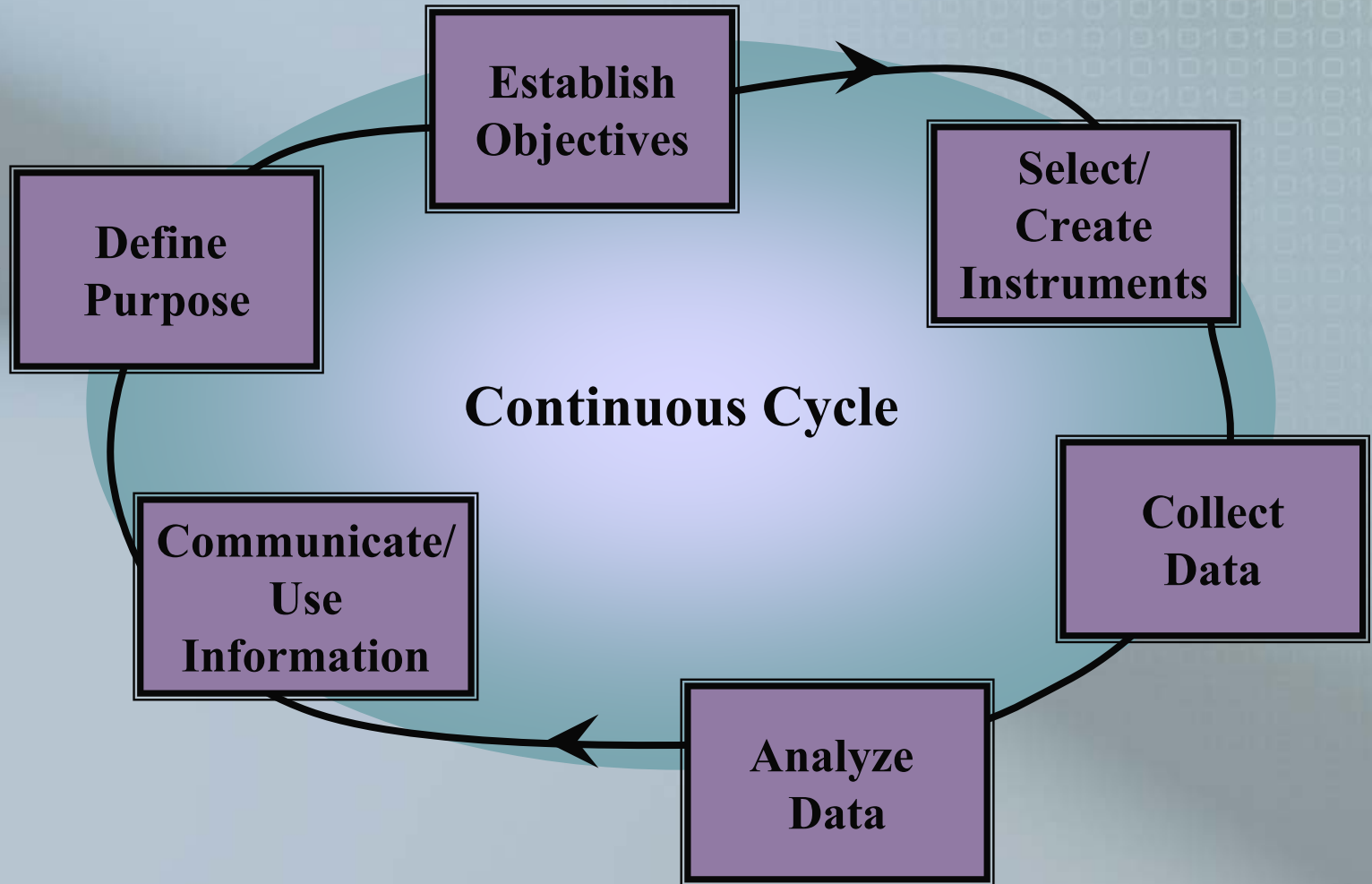
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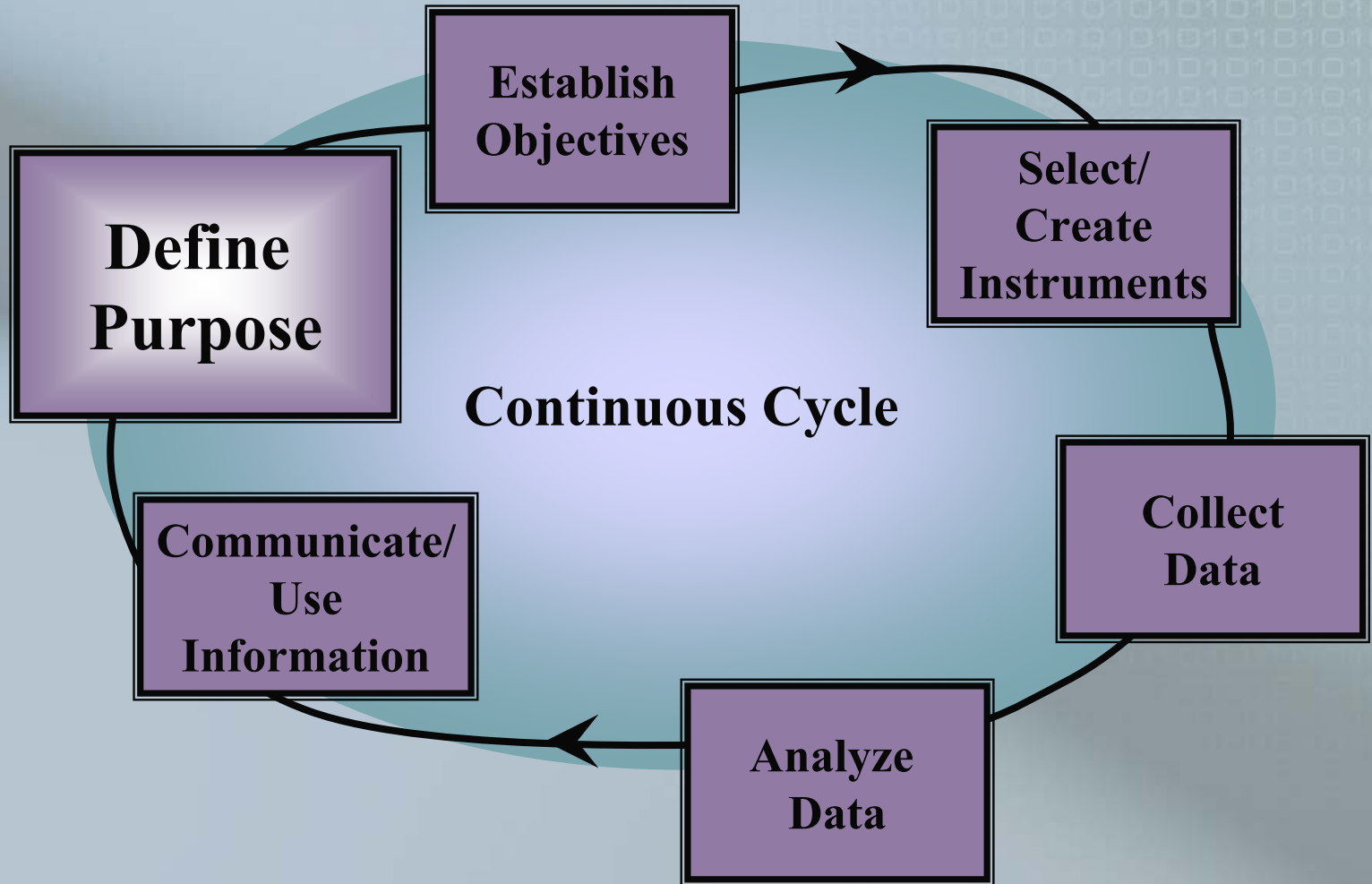
Continued Refinement of an Assessment Instrument: JMU's Scientific and Quantitative Reasoning Tests

<http://www.jmu.edu/assessment>

Assessment Process



Assessment Process





Purpose: Assessing Scientific and Quantitative Reasoning

- SCHEV Core Competencies
- Cluster III of the General Education Program at JMU (The Natural World)
 - Basic methods in math and science
 - Emphasizes scientific and mathematical concepts necessary to be an informed citizen in our society
 - Includes linkage of social and ethical issues to scientific discovery
 - 10 - 12 credit hours

Natural World Packages

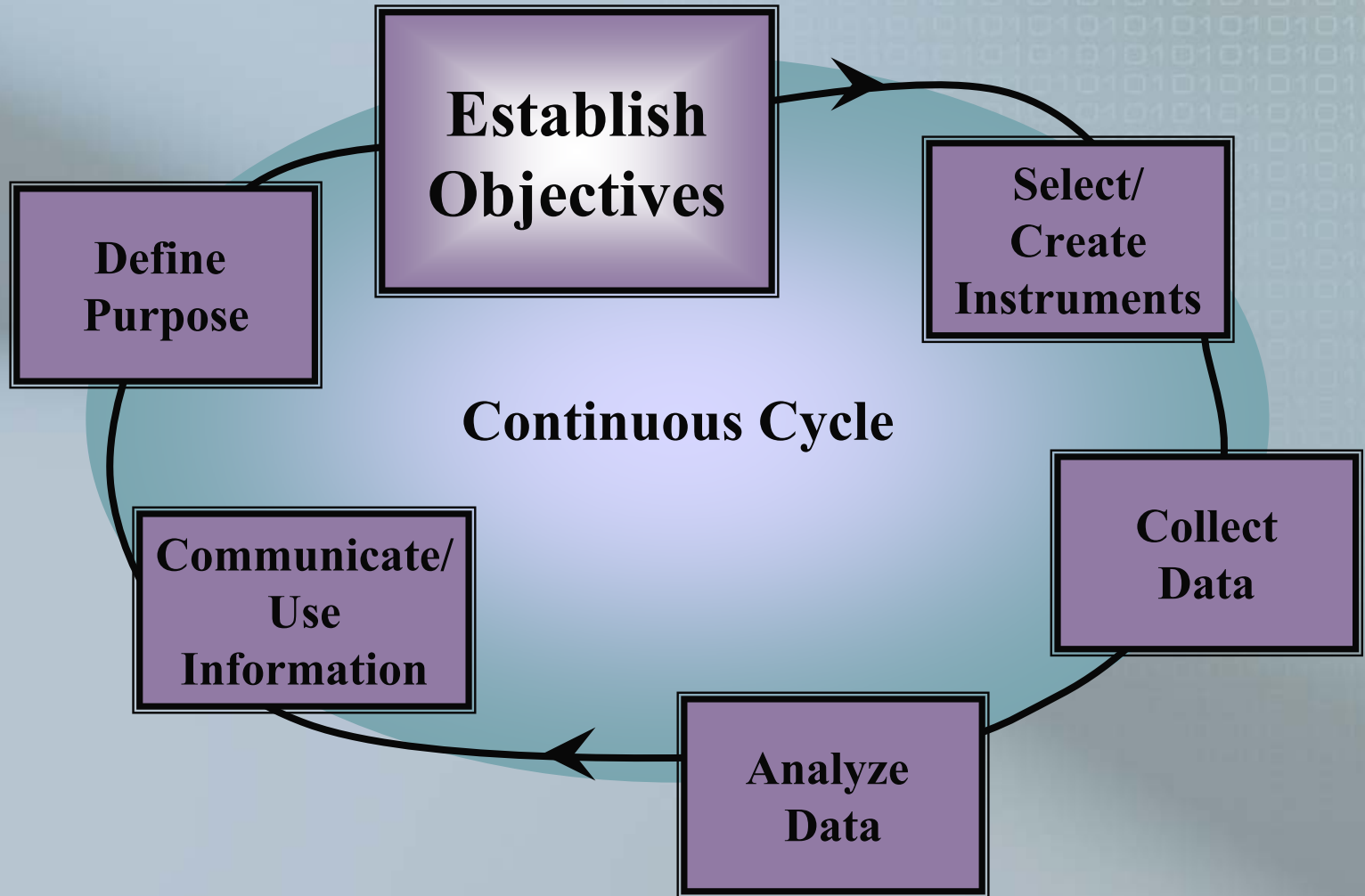
- A. General Science and Math
- B. Integrated Science and Technology
- C. Health Issues
- D. Advanced Science and Math
- E. Humans and the Earth Environment
- F. Light and Sound – Science and Perception
- G. Interdisciplinary Liberal Studies



Principles for Packages

- Founded in and described by cluster learning objectives
- Must meet all cluster objectives
- All packages must be appropriate for and available to all students
- Stated plan for coordination and articulation among the courses
- Consistency in content and requirements across all sections

Assessment Process



Cluster Learning Objectives

- Created by cluster faculty with assistance from CARS
- Start by asking:
 - “What should a student **know** and **be able to do** as a result of completing their coursework in this cluster?”
 - What the student knows and is able to do should NOT be tied to specific courses taken within the cluster.



Scientific Reasoning Objectives (1-3)

1. Describe the methods of inquiry that lead to mathematical truth and scientific knowledge and be able to distinguish science from pseudo-science.
2. Use theories and models as unifying principles that help us understand natural phenomena and make predictions.
3. Recognize the interdependence of applied research, basic research, and technology, and how they affect society.



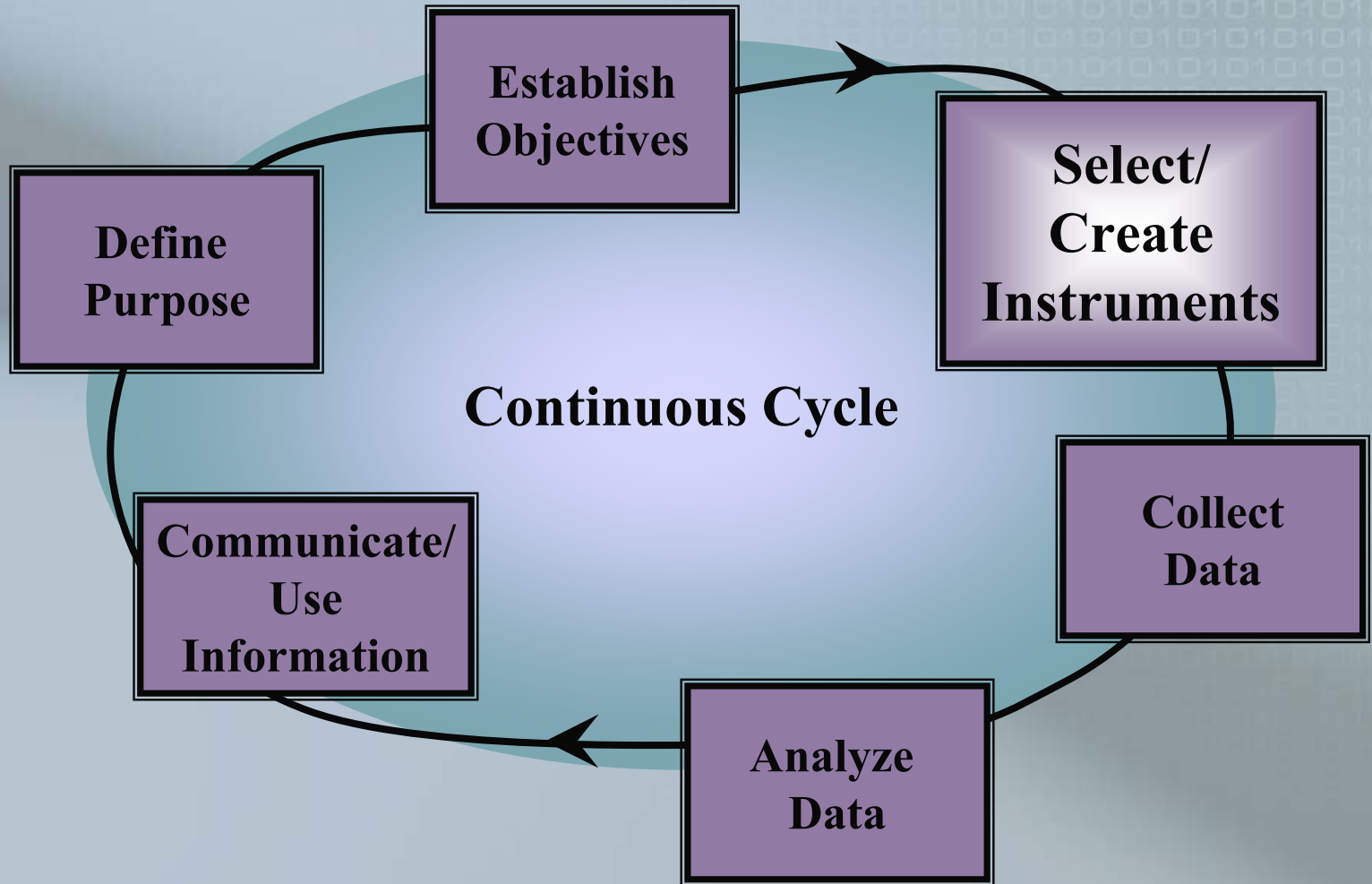
Scientific Reasoning Objectives (4-6)

4. Illustrate the interdependence between developments in science and social and ethical issues.
5. Formulate hypotheses, identify relevant variables, and design experiments to test hypotheses.
6. Evaluate the credibility, use, and misuse of scientific and mathematical information in scientific developments and public-policy issues.

Quantitative Reasoning Objectives

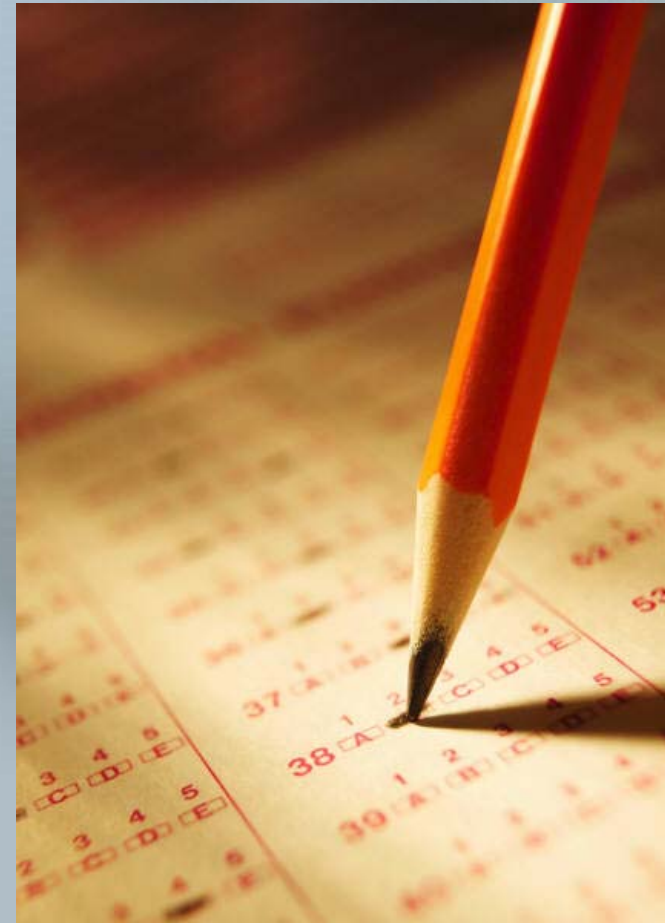
1. Use graphical, symbolic, and numerical methods to analyze, organize, and interpret natural phenomenon.
2. Discriminate between association and causation, and identify the types of evidence used to establish causation.

Assessment Process

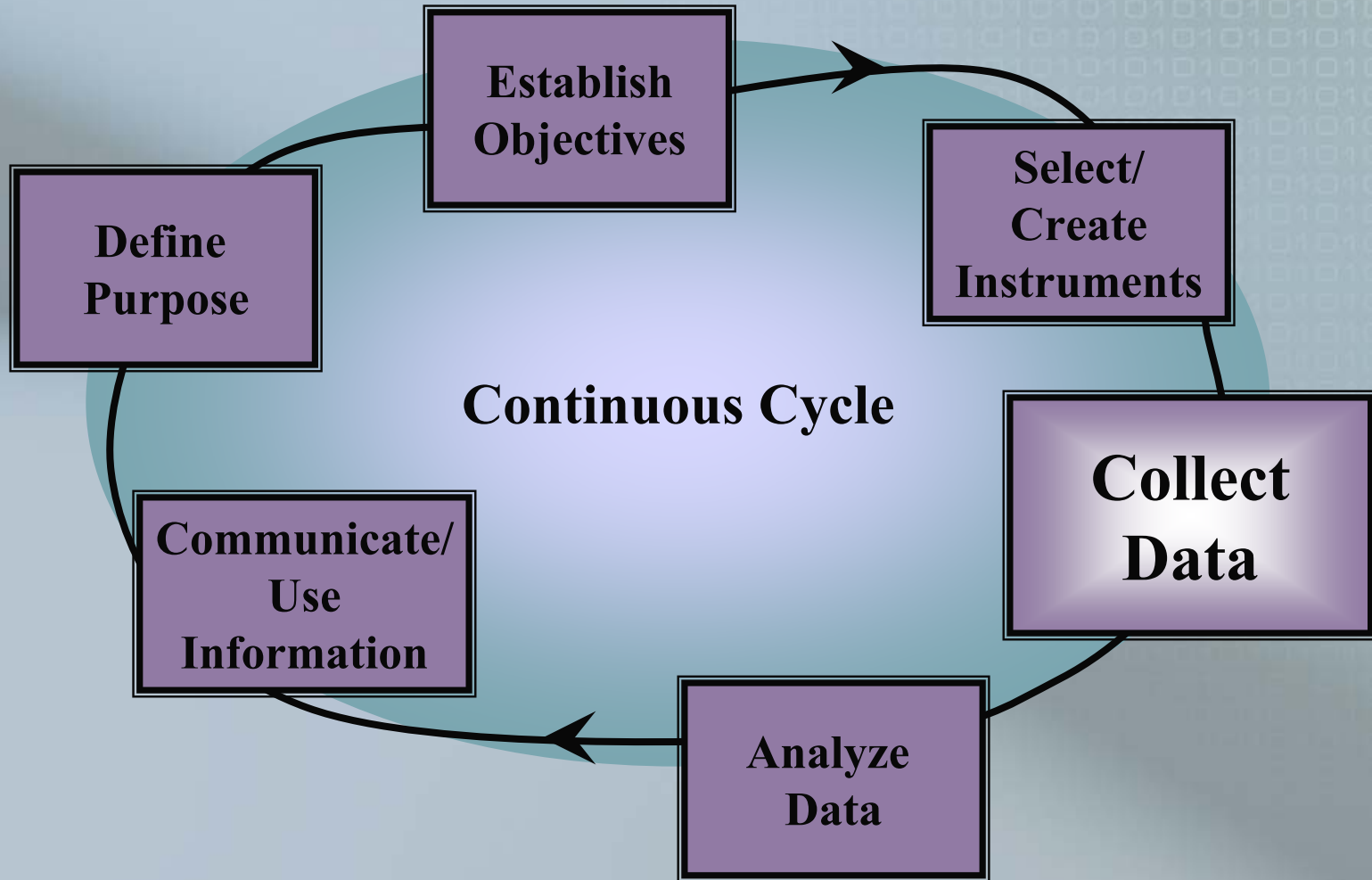


The Scientific and Quantitative Reasoning Tests

- Created by cluster faculty with assistance from CARS
- Assess learning in scientific and quantitative reasoning objectives
- Selected-response items



Assessment Process



Assessment Days at JMU

- Two institution-wide Assessment Days
 - **Fall (August):** Incoming freshmen tested at orientation
 - **Spring (February):** Students with 45-70 cumulative credit hours tested (transfers included)
- Classes cancelled for Spring A-day
- ***All*** students required to participate; otherwise, blocked course registration
- Students randomly assigned to testing rooms



Data Collection Plan: *Repeated Measures*

Fall 2002

Spring 2003

COHORT 1

Fall 2003

Spring 2004

COHORT 2

Fall 2004

Spring 2005

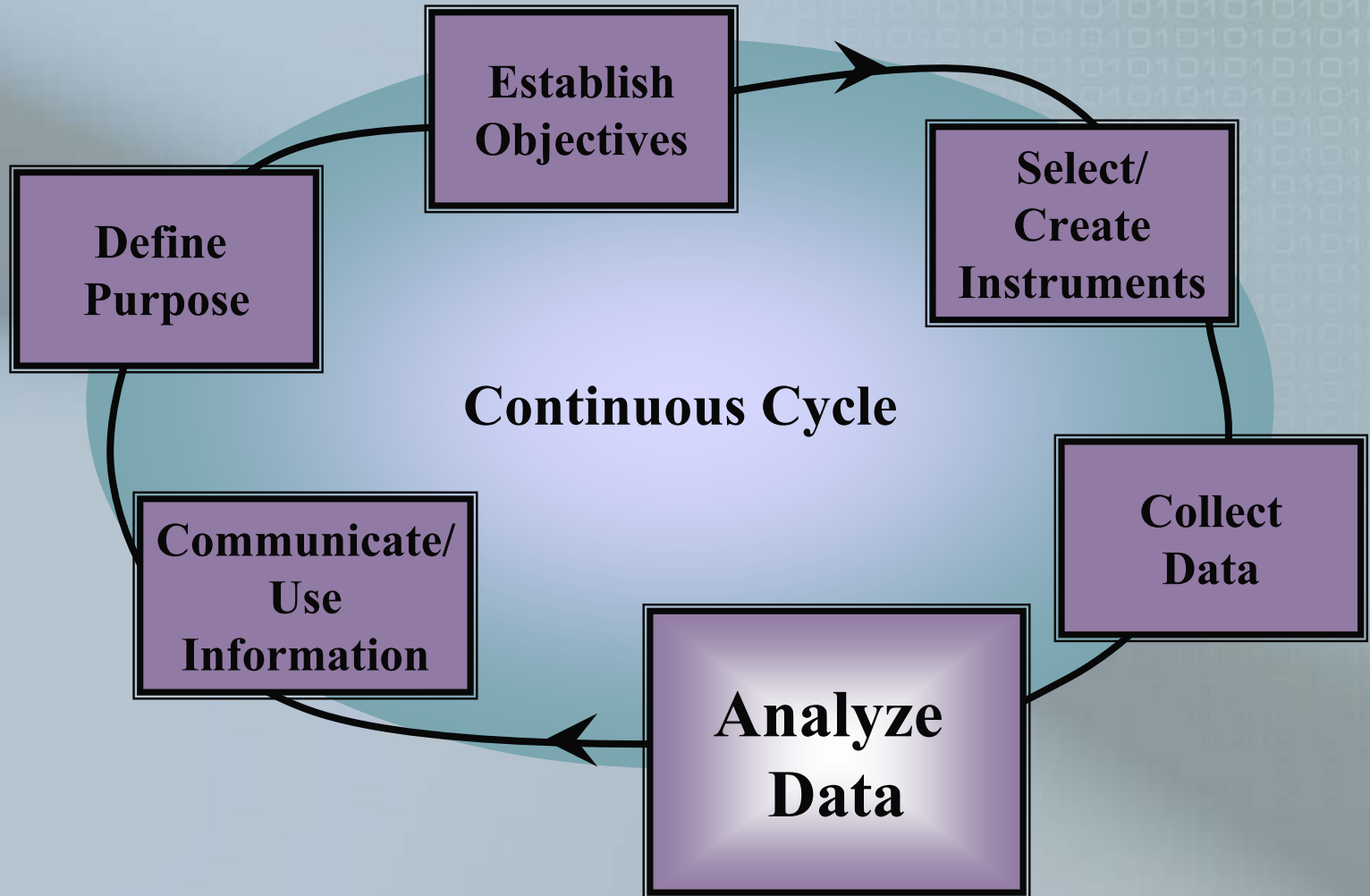
COHORT 3

Fall 2005

Spring 2006

Students in each cohort are tested **twice** on the same instrument – once as **incoming freshmen** and again in the second semester of their **sophomore** year.

Assessment Process



Reliability of the SR

Assessment Day	Test Form	N and Reliability
Fall 1997 Spring 1998	SR-1 [items=76] SR-2 [items=50]	N=532 $\alpha = .60$ N=436 $\alpha = .61$
Fall 1998 Spring 1999	SR-2 SR-2	N=589 $\alpha = .49$ N=393 $\alpha = .69$
Fall 1999 Spring 2000	SR-3 & 4 [items=52] SR-5 [items=50]	N=983 $\alpha = .53$ N=881 $\alpha = .75$
Fall 2000 Spring 2001	SR-5 SR-5	N=993 $\alpha = .65$ N=979 $\alpha = .75$
Fall 2001 Spring 2002	SR-5 SR-5	N=746 $\alpha = .67$ N=801 $\alpha = .77$
Fall 2002 Spring 2003	SR-5 SR-5	N=1084 $\alpha = .69$ N=1174 $\alpha = .75$
Fall 2003 Spring 2004	SR-6 [items=80] SR-6	N=1304 $\alpha = .78$ N=902 $\alpha = .85$
Fall 2004 Spring 2005	SR-7 [items=85] SR-7	N=839 $\alpha = .81$ N=770 $\alpha = .87$

Reliability of the QR

Assessment Day	Test Form	N and Reliability
Spring 2001	QR-5 [items = 27]	N=979 $\alpha = .63$
Fall 2001 Spring 2002	QR-5 QR-5	N=746 $\alpha = .55$ N=801 $\alpha = .64$
Fall 2002 Spring 2003	QR-5 QR-5	N=1084 $\alpha = .54$ N=1174 $\alpha = .63$
Fall 2003 Spring 2004	QR-6 [items=34] QR-6	N=1304 $\alpha = .59$ N=902 $\alpha = .74$
Fall 2004 Spring 2005	QR-7 [items=26] QR-7	N=839 $\alpha = .61$ N=770 $\alpha = .72$



Validity Evidence for the SR and QR

- SR and QR scores increase significantly with increasing numbers of Cluster III courses completed.
- Cluster III-related AP and JMU courses significantly predict SR and QR scores.
- Cumulative credit hours negatively predict SR and QR scores (i.e., test scores are not enhanced via academic maturation through undifferentiated course taking).



Validity Evidence for the SR and QR, cont.

- Over 90% of correlations between course grades and scores on NW-5 and Quantitative Reasoning were positive.
- For Cluster III completers, SR and QR sophomore post-test scores were significantly higher than first-year pre-test scores, and there was *NO* interaction effect produced by Cluster III package completed.

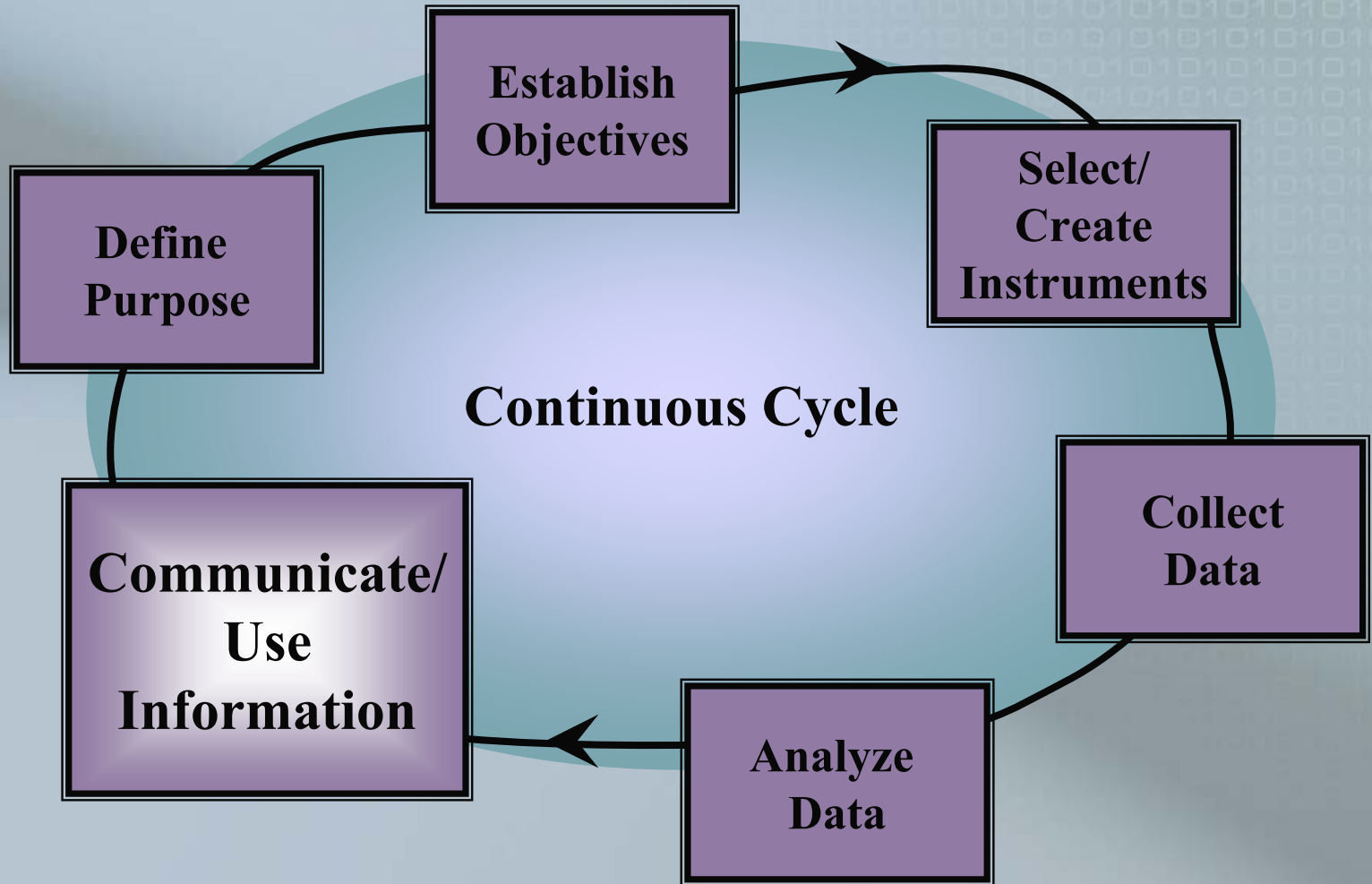
Generalizability of the SR and QR

- 2003 workshop for VCCS faculty
 - 76% of SR/QR-5 items matched to VCCS scientific and quantitative reasoning objectives
 - Faculty adopted one of JMU's objectives because NW-5 items they valued did not match VCCS objectives
- 2004 Virginia Tech SR workshop
 - 84% successful map of JMU items to local objectives
 - Faculty adopted one of JMU's objectives

Generalizability of the SR and QR

- SR and QR tests proved generalizable to learning objectives of institutions with diverse missions
- A step toward developing an infrastructure for credible content validity process and explication (Crocker, 2003; Sireci, 1998)

Assessment Process



Using Assessment Results to Create Version 8

■ Goals

- Reduce number of items
- Maintain reliability
- Maintain balanced coverage of objectives

■ Strategies

- Delete very easy items
- Delete items with low or negative item discrimination
- Examine distractors; use 3 if possible (Rodriguez, 2005)



SR and QR, Version 8

- SR = 50 items
- QR = 20 items

SR Objective	No. (%) of items
1. Methods of inquiry	9 (16.7%)
2. Theories and models	9 (16.7%)
3. Applied/basic research & technology	9 (16.7%)
4. Science and social/ethical issues	10 (18.5%)
5. Hypotheses and experiments	10 (18.5%)
6. Credibility, use, and misuse	7 (13.0%)
QR Objective	
1. Graphical, symbolic, numerical methods	13 (65%)
2. Association and causation	7 (35%)

Version 8 Pilot Test

- Administered Fall 2005
 - $N = 1158$ first-year students
- SR reliability
 - $\alpha = .78$
- QR reliability
 - $\alpha = .57$
- Greater reliability expected for sophomore/junior sample
 - Expected SR $\alpha = .85$
 - Expected QR $\alpha = .70$

Version 8 Validation

- Back translation by JMU faculty and CARS doctoral students
- “Think-alouds” conducted with examinees
- Extensive validation studies following Spring data collection
- Standard setting for SR and QR in Spring 2006
 - JMU faculty
 - VCCS and other faculty

Conclusion

- We have been working collaboratively on SR and QR since 1997.
- With each new version, the tests seem to perform better.
- JMU faculty have elected to use these tests as part of their major assessment designs: Biology, ISAT, IDLS.
- JMU, VCCS, VT have selected these tests for SCHEV core competency reporting.



For more information...

<http://www.jmu.edu/assessment>

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