Using Worked Examples to Facilitate Learning about Research Methods

presented by Anita Ondrusek

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Columbus State University

Columbus, Georgia

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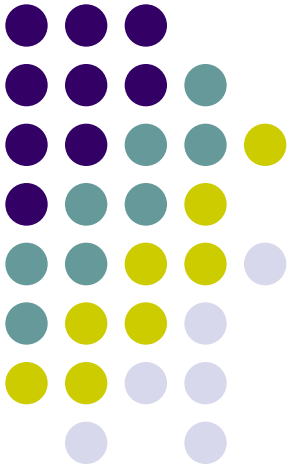
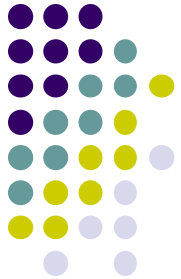


What this presentation will cover:



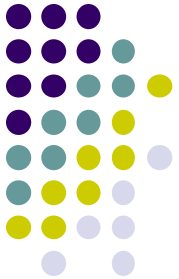
What a Worked Example is

When to use Worked Examples

How to construct a Worked Example

How Worked Examples assist reasoning and problem solving

Using Worked Examples to facilitate learning about research methods



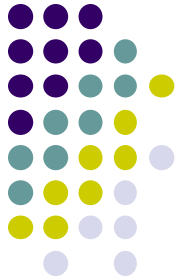
THE BIG PICTURE: REASONING

Definition

Analogical Reasoning

Making a decision about something new in our experience by drawing a parallel to something old in our experience (Sternberg, 1977).

Definition



Analog

A problem that shares the same structure as another problem, but not the same content (referred to as “surface characteristics” or “cover stories”).

Examples of analogs

Composing on a typewriter → Composing on a computer keyboard

Ironing → Guiding a mouse

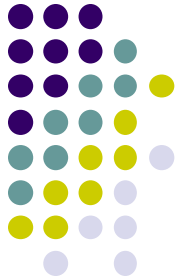
Driving a car → Riding a motorcycle

Watching an apple fall from a tree → Understanding gravity

Viewing a film on values → Applying those values to a personal situation

Reading about a resolution to a problem → Applying it elsewhere

Teaching using analogs



Without analogs, we cannot reason analogically.

What can we do as teachers to help our students acquire analogs?

Research shows that using these three things are effective:

Analogies

Models

Worked Examples

Teaching using analogs

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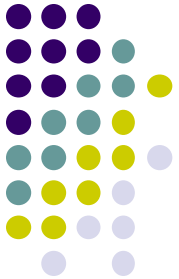
What can we do as teachers to help our students acquire analogs?

Research shows that using these three things are effective:

Analogies

Models

Worked Examples



PART OF THE BIG PICTURE: WORKED EXAMPLES

Definition

Worked Example

A problem from a category of problems that illustrates the correct steps for solving that problem type (Carroll, 1994).

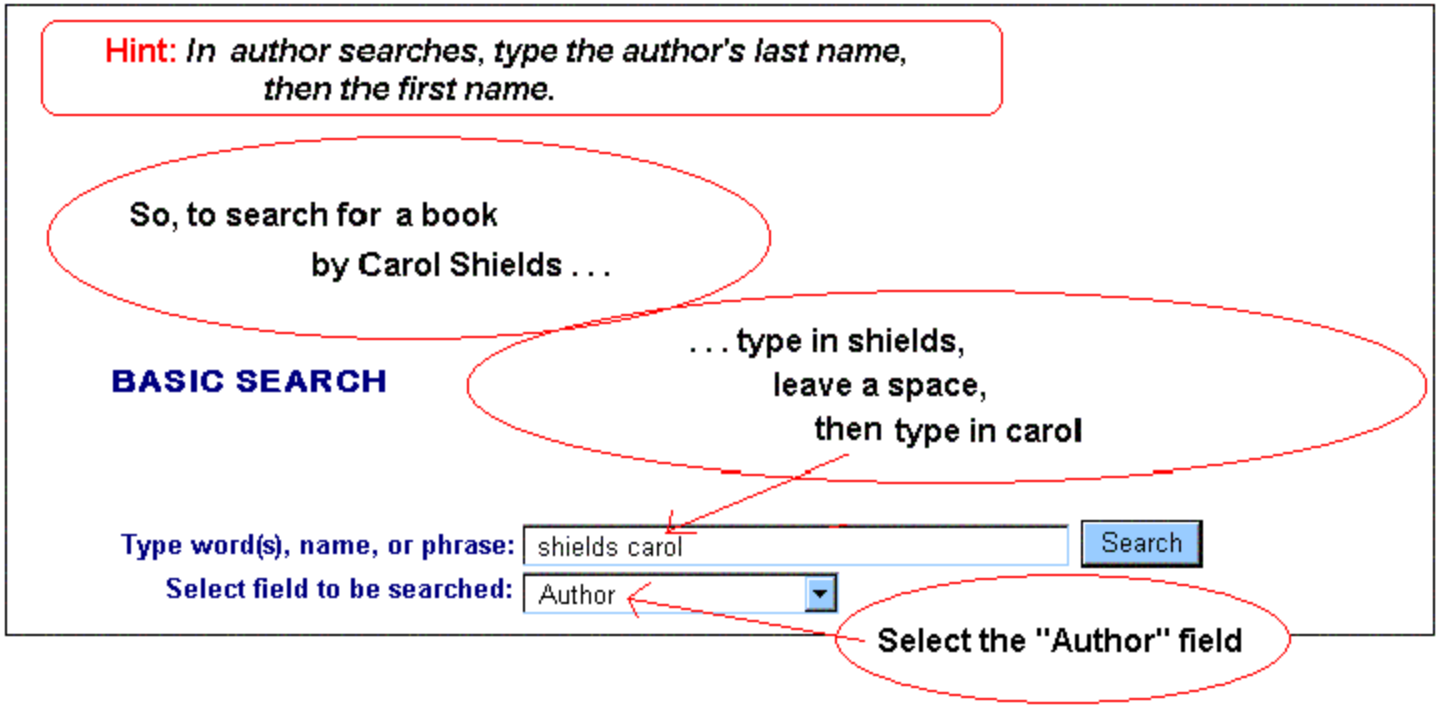
A depiction of the complete solution to a typical problem (Brooks & Crippen, nd).

Illustrated examples vs worked examples

How do they differ?

An illustrated example

states a rule,
then shows
how to apply it



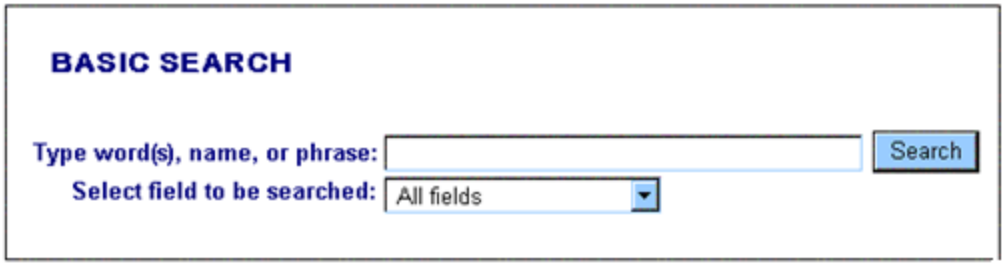
A worked example

states a problem,

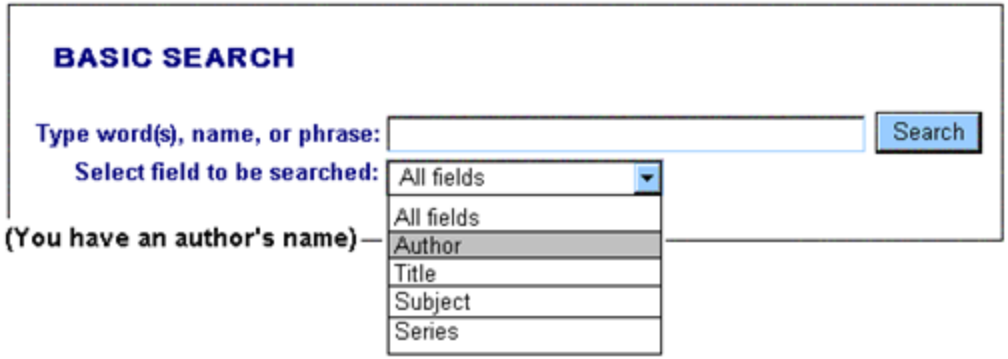
then breaks the procedure for solving it into steps

Enter a search that would find books by Carol Shields in the online catalog.

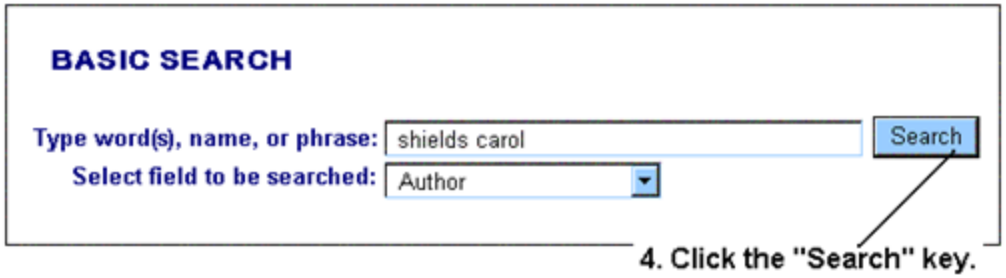
1. Go to the Basic Search screen.



2. Select your search field.



3. Type in last name <space> first name.



Worked Example?

In *algebra*, order of operations

http://www.purplemath.com/modules/orderops2.htm

Worked Example?

In *chemistry*, Carbon-14 dating

http://chemistry.about.com/od/workedchemistryproblems/a/workedproblems.htm

Worked Example?

In *biology*, how to create a Punnett square

http://www2.edc.org/weblabs/Punnett/punnettsquares.html

Worked Example?

In *term paper composition & style*, writing a psychology report

http://writingworkshop.edtec.unsw.edu.au/psyc_report/examples/example1.pdf

Worked Example?

In *English grammer*, diagramming sentences

http://grammar.ccc.commnet.edu/grammar/diagrams2/diagrams_frames.htm

What research tells us about worked examples

The following excerpts were retrieved from an Exhibit on the website of the *Journal of Online Education* at http://www.innovateonline.info/extra/exhibit192.

What research tells us

Research supports the assertion that novice learners rely heavily on examples during problem solving (Chi et al. 1989) and that examples support problem-solving efforts (Atlas 1996).

What research tells us

Sweller (1999) asserts that conventional problem solving (learning-by-doing) requires learners to engage in search strategies to discover the problem structure and rules. However, the primary types of search strategies, such as *trial and error* and *means-ends analysis*, impose a heavy cognitive load that interferes with learning. As an alternative, Sweller encourages the incorporation of worked examples, which present learners with step-by-step problem solutions. Worked examples offer learners the opportunity to find the method of problem solving through the examination of these examples.

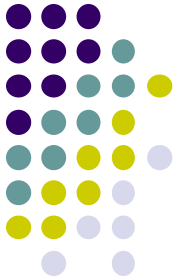
What research tells us

Even though examples provide information relevant to skill learning for novice learners, there are some downsides *if such an approach is not sufficiently linked with practice* . . . worked examples *alone* do not provide opportunities for learners to transform declarative knowledge into procedural knowledge for skill acquisition (Anderson 1983).

What research tells us

When offering practice problems for novice learners, it should also be taken into account whether learners are provided with *independent practice opportunities*, *rather than mechanical practice opportunities* for entering the given steps for the correct solution to a problem (Charney, Reder, and Kusbit 1990).

Creating worked examples



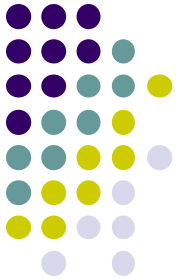
To help students, worked examples must be:

- based on well-defined problems (ones with a single “correct” answer)
- presented in a step-by-step format

Each worked example should:

- begin with a statement of the problem
- show the complete solution
- elaborate upon what happens in each step
- follow with practice problems that gradually “fade” assistance (leave more and more steps for the learner to complete)

How to use worked examples



Give worked examples to novice learners.

Two or more worked examples might be necessary.

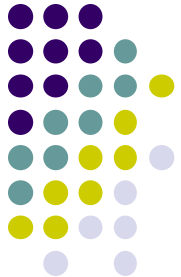
Use worked examples as:

- scaffolding (helping students do what they can't do alone)
- guides for solving other problems like the ones in the examples

Always follow a worked example by assigning practice problems.

Assess learning from worked examples with problems that require a transfer of skills to a new situation.

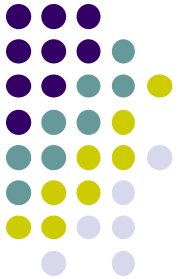
Transfer of learning into problem solving



Practice progresses from mechanical practice into opportunities to use the procedures learned in a new situation

To do this:

- gradually reduce, then eliminate scaffolding
- make problems more complex
- embed application in high-stakes assessments



USING WORKED EXAMPLES TO TEACH RESEARCH METHODS

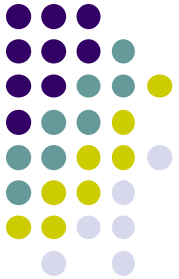
Clear links to course objectives

In the MLIS course on research methods at VSU, worked example activities relate to these course objectives:

- Distinguish between qualitative and quantitative research methods
- Identify the basic elements in the design of social research studies
- Relate terminology, concepts, and processes of social research to studies conducted in the field of library and information science (LIS)

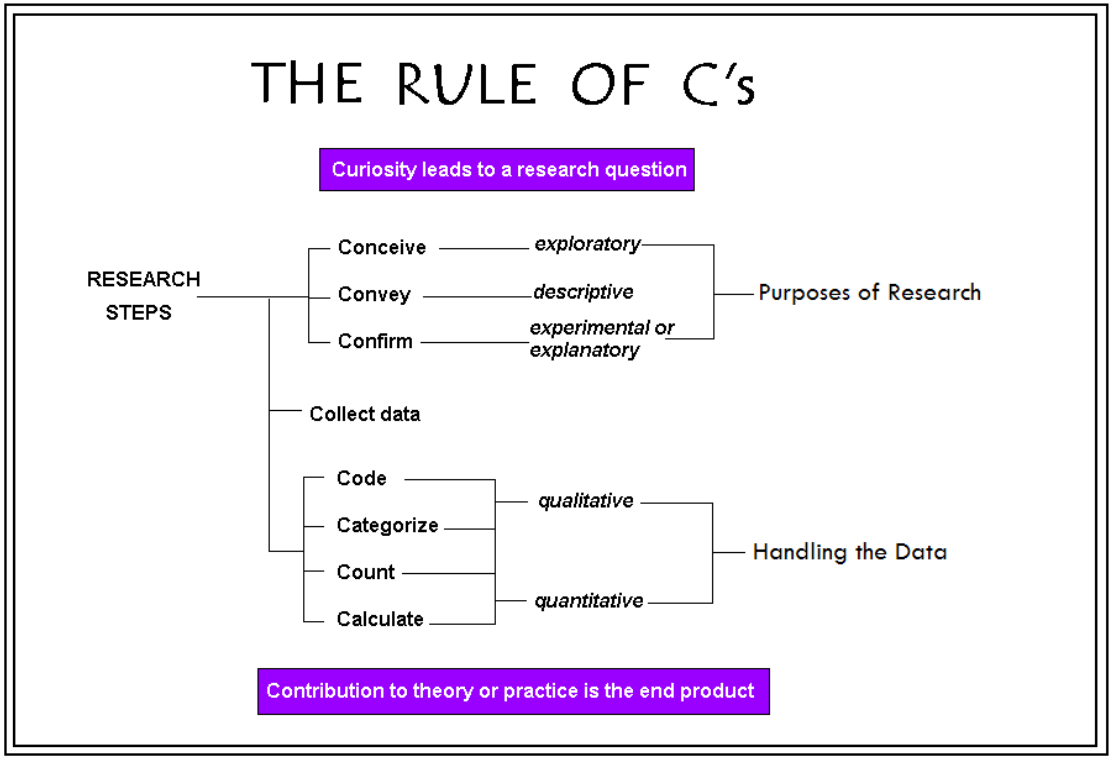
The activities contribute to this higher-order assessment:

- Evaluate research methodologies from representative LIS research studies



Pre-requisite Learning

Conceptualizing a study



ELEMENTS OF RESEARCH DESIGN
COMPARISON CHART: QUALITATIVE vs. QUANTITATIVE

Elements of Research Design	Qualitative Approach	Quantitative Approach
Logical model that forms its basis	Based on inductive logic	Based on deductive logic
How values are addressed	Can be atheoretical and all values and perspectives are open to consideration	Uses a theory-driven, value-free approach
Paradigms unique to each approach	Ethnography, Phenomenology, Case Study	Scientific method, Controlled experimentation
Types of investigation	Often exploratory or interpretive, can also be descriptive.	Often descriptive, can also be explanatory (explains cause-effect) or confirmatory (confirms or refutes a hypothesis)
Research setting	Conducted in a real-world, naturalistic setting	Conducted in a controlled setting (e.g., lab)
How subjects are selected	Purposive sampling is mostly employed	Random sampling is the ideal
Relations with subjects	Researchers may interact with subjects, sometimes as an "active participant"	Researchers avoid interactions with participants
Numbers needed to conduct a study	Small sample sizes are acceptable	Large sample sizes needed to produce more reliable results
Constructs and variables	Constructs and variables are defined as a result of the investigation	Constructs and variables are defined at the start of the investigation

Hallmarks of a rigorous study design	Triangulation – three separate data collection methods are employed	The scientific experiment –varying treatments are administered to randomly-assigned groups
Data collection methods	Designed to elicit first-hand accounts. Commonly-used methods: Field observation (the researcher takes notes or keeps a journal or films events); Self reports (the participants in the study keep diaries or journals or write narratives); Interviewing (individuals) or Focus group; Critical incident (recalling an incident); Verbal protocol (subjects asked to think aloud); Shadowing (documenting movements); Delphi study (questions posed to experts in repeated rounds); Interactive tests (drawing pictures, creating concept maps, telling stories, playing games).	Designed so that data can be counted. Commonly-used methods: Surveys or Questionnaires; Objective tests (e.g., multiple choice); Bibliometric measures (e.g. citation analysis); Examining extant data (e.g. census records); Transaction captures (of computer logs or screens) also known as transaction log analysis. P.S. Quantitative data collection methods can be adapted for qualitative data collection. For example, a questionnaire composed of open-ended questions to elicit first-hand information would be a qualitative method.
Data analysis methods	Aims to preserve the original data. Commonly-used methods: Grounded theory analysis; Protocol analysis (think-alouds coded); Creating a taxonomy or typology; Content analysis (usually coding text).	Uses statistical analysis to reduce data. Commonly-used methods: Frequency counts converted to percentages; Cross tabulation (rows and columns of data); Comparing means (average scores); Content analysis (usually counting occurrences).

Worked Example on finding mean, median, and mode for grouped data

Find the Mean, Median and Mode for the following grouped data:

Mass(kg)	Frequency
41 - 45	7
46 - 50	10
51 - 55	15
56 - 60	2
61 - 65	6

STEP 1

We do not know actual masses, so approximate by choosing the midpoint of each group, using this procedure:

Mass(kg)	Midpoint
41 - 45	$(41+45)\div 2 = 43$
46 - 50	$(46+50)\div 2 = 48$
51 - 55	$(51+55)\div 2 = 53$
56 - 60	$(56+60)\div 2 = 58$
61 - 65	$(61+65)\div 2 = 63$

STEP 2

Multiply each midpoint times the frequency.

Mass(kg)	Midpoint		Frequency	Midpt * freq
41 - 45	$(41+45)\div 2=$	43	7	$43\times 7=301$
46 - 50	$(46+50)\div 2=$	48	10	48 X 10 = 480
51 - 55	$(51+55)\div 2=$	53	15	53 X 15 = 795
56 - 60	$(56+60)\div 2=$	58	2	58 X 2 = 116
61 - 65	$(61+65)\div 2=$	63	6	63 X 6 = 378

STEP 3

Sum the frequencies and the midpoints.

Mass(kg)	Midpoint		Frequency	Midpt * freq
41 - 45	$(41+45) \div 2 = 43$		7	$43 \times 7 = 301$
46 - 50	$(46+50) \div 2 = 48$		10	480
51 - 55	$(51+55) \div 2 = 53$		15	795
56 - 60	$(56+60) \div 2 = 58$		2	116
61 - 65	$(61+65) \div 2 = 63$		6	378
		total	50	2070

STEP 4

To calculate the mean, divide the sum of the midpoints by the sum of the frequencies.

Frequency	Midpt * freq
7	$43 \times 7 = 301$
10	480
15	795
2	116
6	378
50	2070

$$\text{Mean} = \frac{2070}{50} = 41.4$$

STEP 5

Find the mode by identifying the group with the highest frequency.

Mass(kg)	Frequency	Midpt * freq
41 - 45	7	$43 \times 7 = 301$
46 - 50	10	480
51 - 55	15	795
56 - 60	2	116
61 - 65	6	378
	50	2070

STEP 5

Here the modal group = 51-55

Mass(kg)	Frequency	Midpt * freq
41 - 45	7	$43 \times 7 = 301$
46 - 50	10	480
51 - 55	15	795
56 - 60	2	116
61 - 65	6	378
	50	2070

STEP 6

Find the median by identifying the midpoint.
In this problem, look for where the 25th and 26th terms are.

Mass(kg)	Frequency	Midpt * freq
41 - 45	7	$43 \times 7 = 301$
46 - 50	10	480
51 55	15	795
56 - 60	2	116
61 - 65	6	378
	50	2070

STEP 6

Here the median lies between 50-51.

Mass(kg)	Frequency	Midpt * freq
41 - 45	7	$43 \times 7 = 301$
46 - 50	10	480
51 - 55	15	795
56 - 60	2	116
61 - 65	6	378
	50	2070

Worked Example on calculating variance

Problem: Calculate variance from raw scores.

1.
Sum your raw scores (X)

24
22
20
21
14
101

Group 1 has 5 scores that sum to 101.

2.
Calculate the mean score (M):

divide the sum of scores 101
by the number of scores. 5

$M = 20.2$

3.
Subtract the mean from each raw score

X–M

24 – 20.2 = 3.8
22 – 20.2 = 1.8
20 – 20.2 = -.8
21 – 20.2 = .8
14 – 20.2 = -6.2

4.
Square the results

$(X\text{-}M)^2$

14.43
3.24
.64
.64
38.44

5.
Sum the results

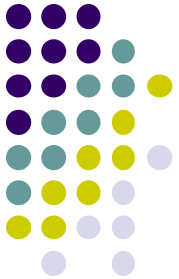
14.43
3.24
.64
.64
38.44
57.36

6.
Divide the sum of the squared values 57.36

by the number of scores minus 1 4

7.
Solution:

57.36 ⁄ 4 = 14.32 ← Variance



A Worked Example Approach to Data Collection

Extracting data from the U. S. Census

Students first study a worked example showing how to locate data in the census charts

The following excerpts show how to use further scaffolding techniques to guide them through a practice exercise that requires them to locate specific data in the census database.

Provide a facsimile of how data is arranged with one data set entered.

Variables	Georgia
Income SF3	
Median nonfamily householder income 65+	**SF3** (PCT42)
Male living alone	15,439
Female living alone	12,579
Aggregate nonfamily householder income 65+	**SF3** (PCT43)
Male living alone	10,958,924,200
Female living alone	3,693,963,60

Partially fill in a second data set. The entered data helps guide students.

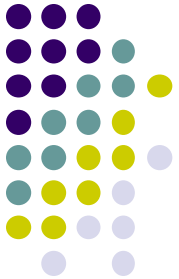
Variables	Georgia	Atlanta*
Income SF3		
Median nonfamily householder income 65+	SF3 (PCT42)	SF3 (PCT42)
Male living alone	15,439	19,052
Female living alone	12,579	X
Aggregate nonfamily householder income 65+	SF3 (PCT43)	SF3 (PCT43)
Male living alone	10,958,924,200	X
Female living alone	3,693,963,60	1,545,114,100

A third data set requires students to locate data at the next level.

Variables	Georgia	Atlanta*	Forsyth County
Income SF3			
Median nonfamily householder income 65+	SF3 (PCT42)	SF3 (PCT42)	SF3 (PCT42)
Male living alone	15,439	19,052	X
Female living alone	12,579	X	X
Aggregate nonfamily householder income 65+	SF3 (PCT43)	SF3 (PCT43)	SF3 (PPCT43)
Male living alone	10,958,924,200	X	X
Female living alone	3,693,963,60	1,545,114,100	X

Ask students to locate data for a new "target" without guides.

Variables	Georgia	Atlanta*	Forsyth County	GA Town/City or County of your choice
Income SF3				
Median nonfamily householder income 65+	SF3 (PCT42)	SF3 (PCT42)	SF3 (PCT42)	
Male living alone	15,439	19,052	X	
Female living alone	12,579	X	X	
Aggregate nonfamily householder income 65+	SF3 (PCT43)	SF3 (PCT43)	SF3 (PPCT43)	
Male living alone	10,958,924,200	X	X	
Female living alone	3,693,963,60	1,545,114,100	X	



A Worked Example Approach to Identifying Research Designs

Diagramming abstracts

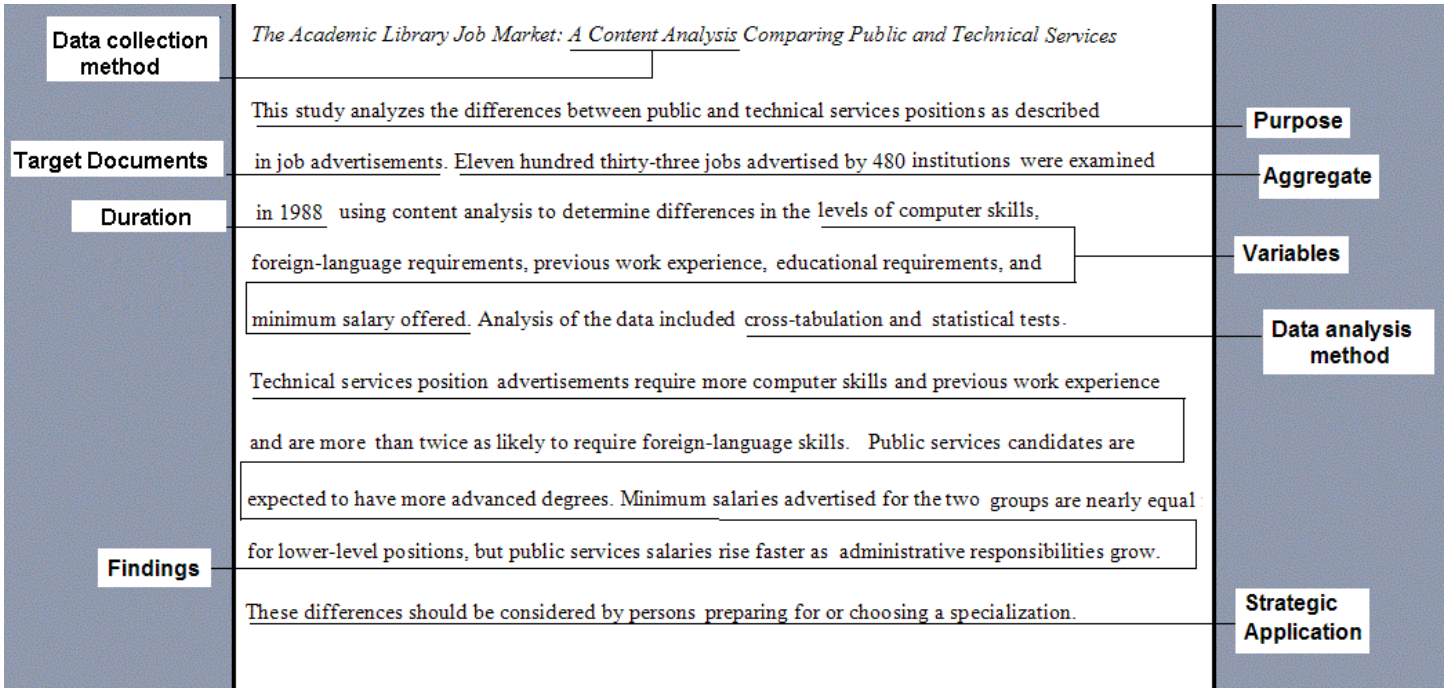
INSTRUCTIONS TO THE STUDENTS:

On the next few slides, you will see abstracts from actual LIS research articles.

Categorize these studies as either qualitative or quantitative.

Look for clues in the research design.

Worked example for diagramming an abstract of a quantitative study



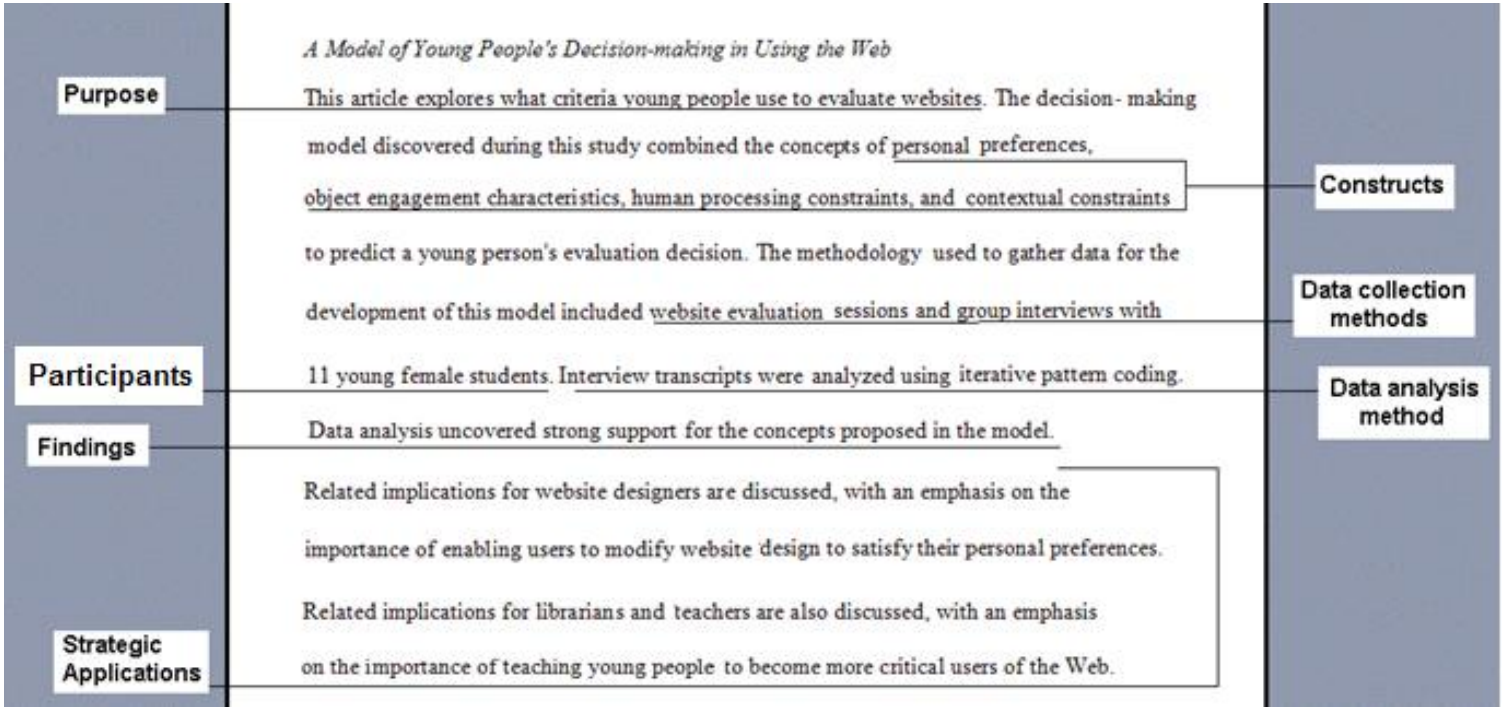
Follow-up thought exercise for students:

What research design elements make this study quantitative?

Possible answers:

1133 job ads
Variables quantified
Cross tabulation

Worked example for diagramming an abstract of a qualitative study



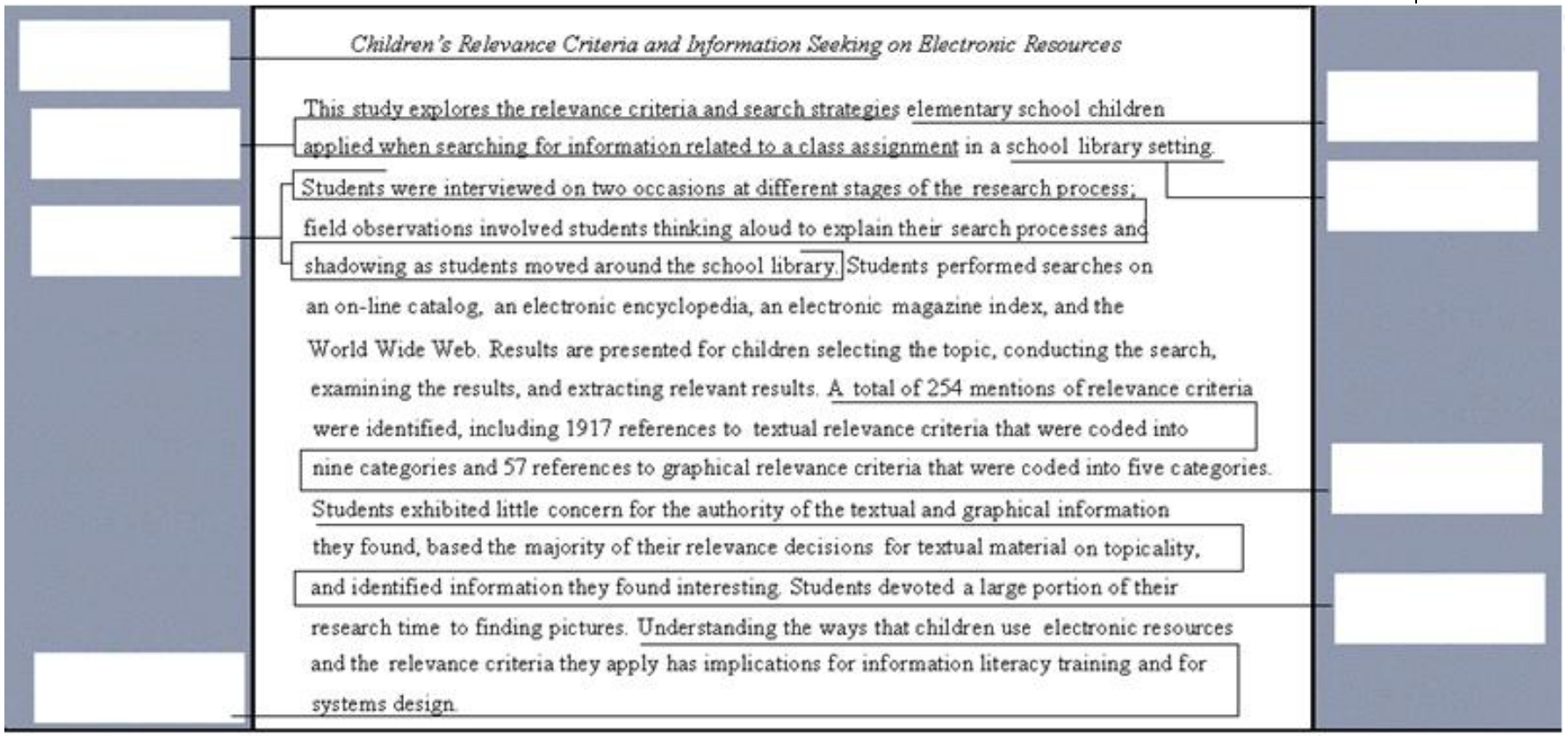
Follow-up thought exercise for students:

What research design elements make this study qualitative?

Possible answers:

11 participants
Constructs examined
Interviews conducted

Practice exercise for diagramming an abstract of a qualitative study



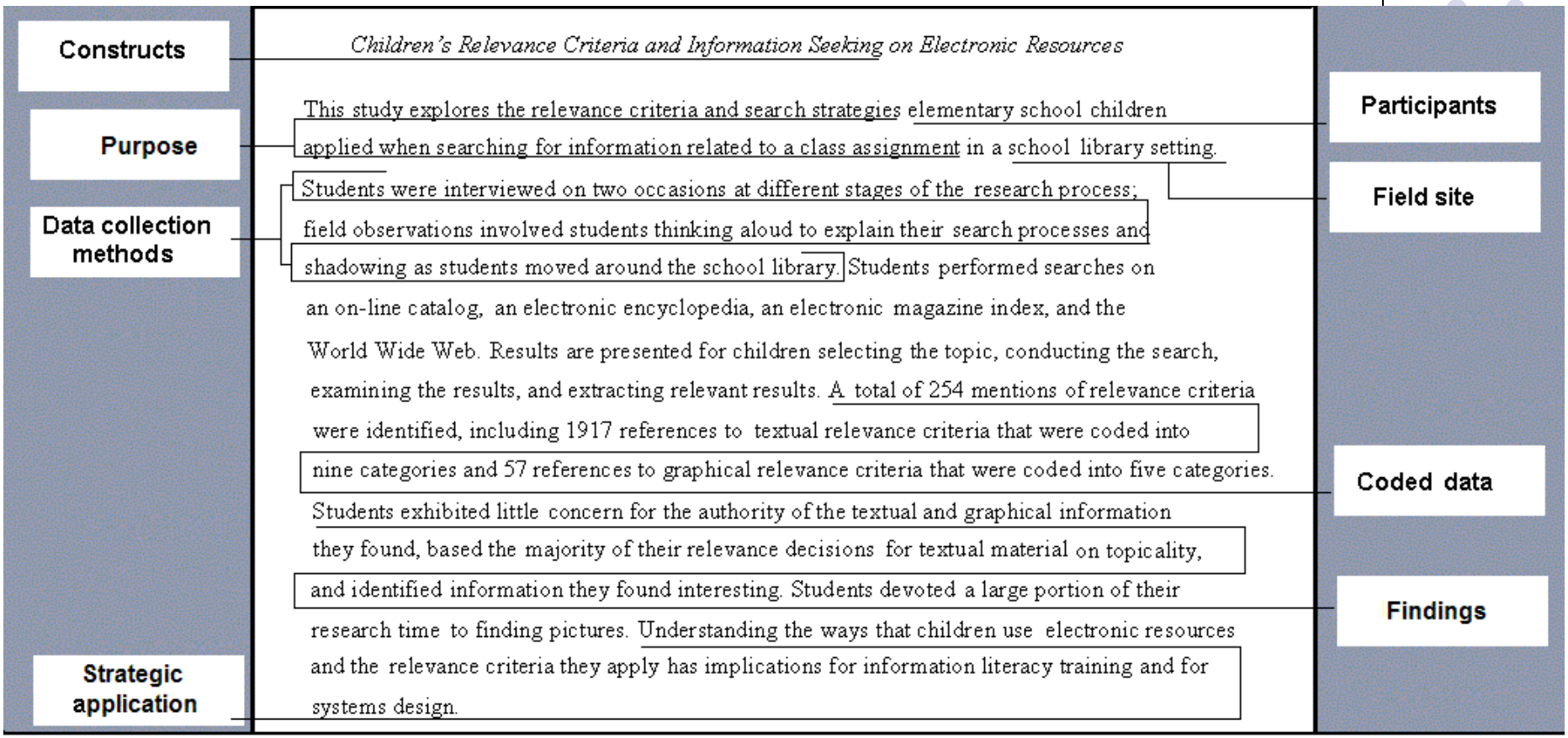
Children's Relevance Criteria and Information Seeking on Electronic Resources

This study explores the relevance criteria and search strategies elementary school children applied when searching for information related to a class assignment in a school library setting. Students were interviewed on two occasions at different stages of the research process; field observations involved students thinking aloud to explain their search processes and shadowing as students moved around the school library. Students performed searches on an on-line catalog, an electronic encyclopedia, an electronic magazine index, and the World Wide Web. Results are presented for children selecting the topic, conducting the search, examining the results, and extracting relevant results. A total of 254 mentions of relevance criteria were identified, including 1917 references to textual relevance criteria that were coded into nine categories and 57 references to graphical relevance criteria that were coded into five categories. Students exhibited little concern for the authority of the textual and graphical information they found, based the majority of their relevance decisions for textual material on topicality, and identified information they found interesting. Students devoted a large portion of their research time to finding pictures. Understanding the ways that children use electronic resources and the relevance criteria they apply has implications for information literacy training and for systems design.

INSTRUCTIONS: Place each research term (below) in the box beside the underlined element in the abstract (above) that fits its meaning.

Data collection methods	Field site	Constructs	Strategic application
Participants	Findings	Quantified data	Purpose

Provide correct answers to a practice exercise



Follow-up thought exercise for students:

What does your diagram of the abstract tell you about the study?

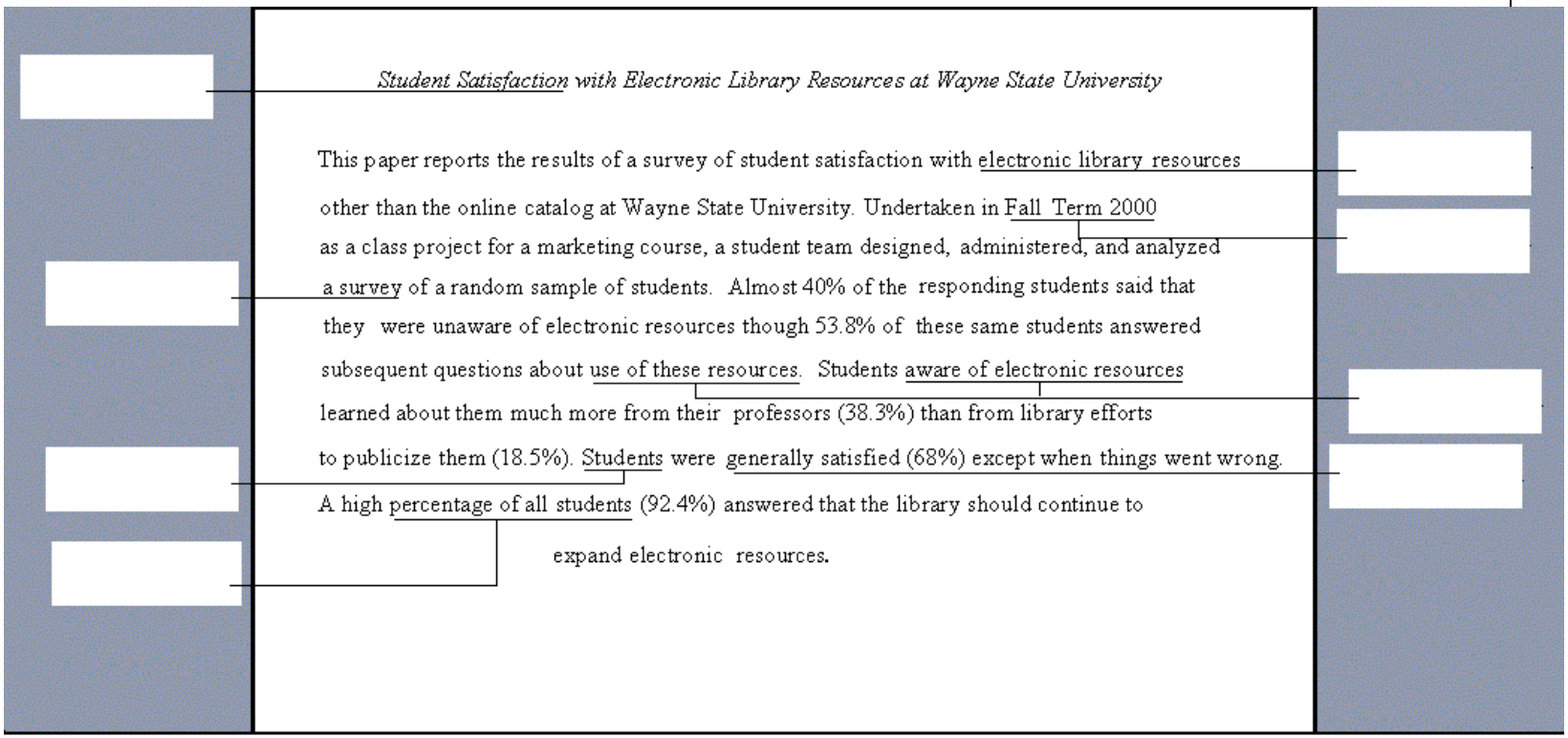
Qualitative or Quantitative?

Why?

Possible answers:

- Exploration of a single phenomena
- Conducted in the field
- Interviews and field notes used

Practice exercise for diagramming an abstract of a quantitative study



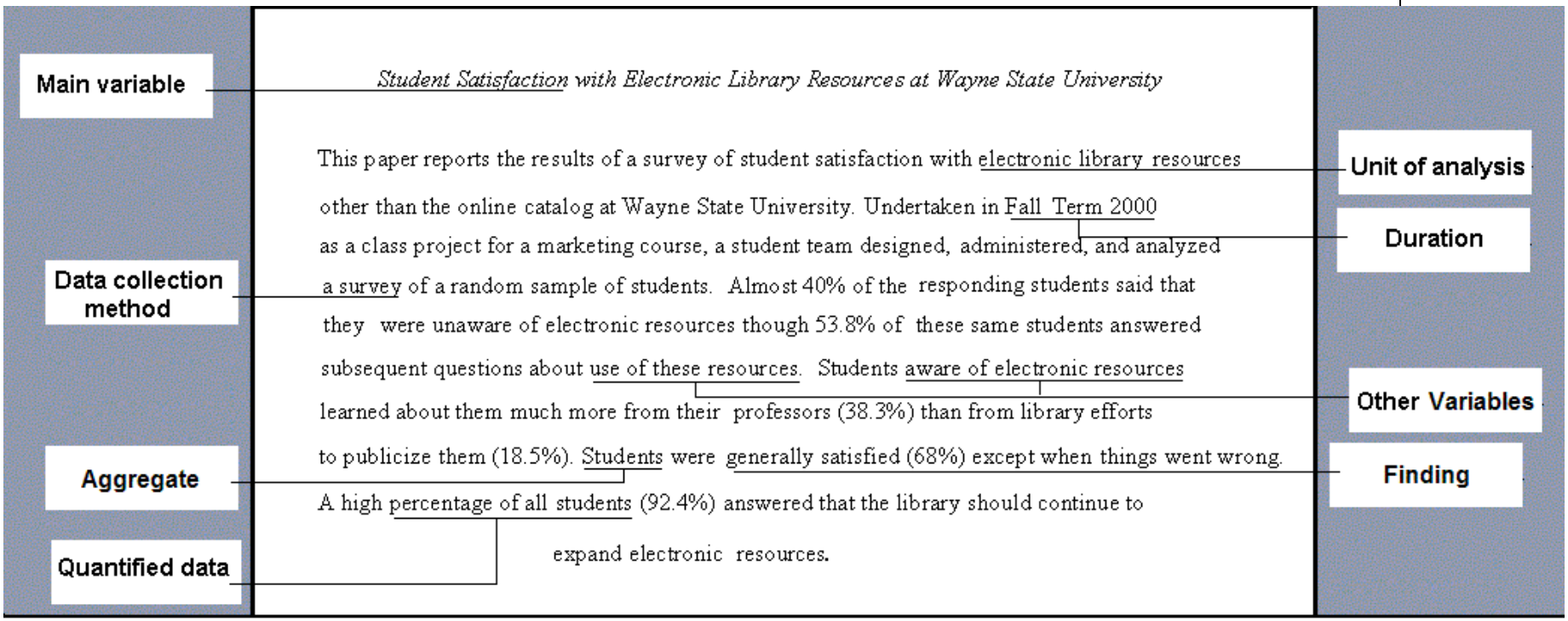
Student Satisfaction with Electronic Library Resources at Wayne State University

This paper reports the results of a survey of student satisfaction with electronic library resources other than the online catalog at Wayne State University. Undertaken in Fall Term 2000 as a class project for a marketing course, a student team designed, administered, and analyzed a survey of a random sample of students. Almost 40% of the responding students said that they were unaware of electronic resources though 53.8% of these same students answered subsequent questions about use of these resources. Students aware of electronic resources learned about them much more from their professors (38.3%) than from library efforts to publicize them (18.5%). Students were generally satisfied (68%) except when things went wrong. A high percentage of all students (92.4%) answered that the library should continue to expand electronic resources.

INSTRUCTIONS: Place each research term (below) in the box beside the underlined element in the abstract (above) that fits its meaning.

Aggregate	**Duration**	**Main variable**	**Quantified data**
Data collection method	**Finding**	**Other Variables**	**Unit of analysis**

Provide correct answers to a practice exercise



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Qualitative or Quantitative?

Why?

Possible answers:

- Random sampling
- Survey designed to measure variables
- Data reported in percentages

Start fading out scaffolding.
You can stick with mechanical practice.

Match these research elements to each one's position in the abstract :

Researcher's purpose	**Participants**
Data collection methods	**Field site**
Data analysis methods	**Duration**
Constructs	**Findings**

The Keys to the Kingdom Have Been Distributed:
An Organizational Analysis of an Academic Computing Center

The use of cultural analysis as a tool with which to understand various organizational phenomena is not a new concept. However, it is one that has been infrequently applied to library research. This article focuses on the use of cultural analysis to study an academic computing center. During the 1990's, the institution's computing environment changed from a mainframe system (under the complete control of the academic computing center's programmers) to one with distributed computing systems (250 personal workstations). After that change, the center was revamped from a hierarchical structure to a unit overseen by a director's team (DT) consisting of the director and seven associate directors (AD). The data consisted of formal interviews conducted in the office of each member of the DT and extensive field notes based on observations of DT meetings and other events conducted during a three-week period in October, 1994. Both interviews and field notes were content coded and analyzed using a grounded theory approach. The results reveal a department in crisis partially explained by its members' inability to adapt to the changes brought about by the new environment's focus on customer support in a radically different system. The study was conducted in order to understand the culture of computing professionals and to assist librarians in developing ways in which the two groups of professionals can work together in a rapidly changing information climate to better serve the needs of library users.

Or, you can create a more challenging opportunity for practice.

Label the research elements in this abstract.

The Keys to the Kingdom Have Been Distributed:
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Make sure you have assessment exercises for both qual and quan.

Match these research elements to each one's position in the abstract :

Researcher's purpose	**Aggregate studied**
Data collection methods	**Quantified data**
Target documents	**Duration**
Variables	**Findings**

Database Use Patterns in Public Libraries

To determine patterns of use in databases, a random sampling of database usage records in ninety-eight public libraries and library systems in the United States and Canada was studied during a six-month period. Library users at all sizes of libraries tended to use research databases most frequently early in the week, at midday, and at times that correspond to the academic calendar (November in this six-month sample). Peak usage varied with size of library, but capacity of between one and ten simultaneous users will satisfy 99 percent of demand in every size library. A questionnaire sent to these libraries revealed many other factors that might influence database use, including posting signs or preparing handouts, availability of remote login, and placement of a database on the library's homepage. Only the number of workstations, adjusted for population, was found to be statistically correlated with amount of use.

Make sure you present each assessment in the same manner.

Label the research elements in this abstract.

Database Use Patterns in Public Libraries

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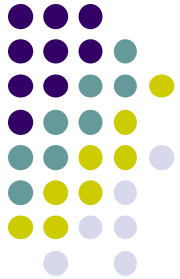
Provide the correct answers in your feedback.
Be prepared to remediate for those students who failed in this exercise.



For the more challenging practice, you still need to decide in advance what types of labels you would expect students to provide and what variations on those answers you will accept.

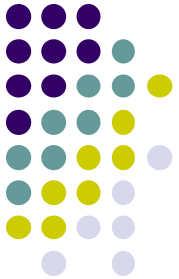
Researcher's purpose
Aggregate studied
Data collection methods
Quantified data
Target documents
Duration
Variables
Findings

Structure the thought question exactly like questions used for practice:

What does your diagram of the abstract tell you about the study?

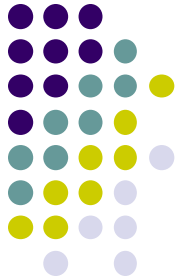
Qualitative or Quantitative?

Why?



Ultimate assessment . . .

Include an abstract that reflects your research design in your final proposal



Assessment recommendations:

- Have students review each other's abstracts.
- Align grading criteria with what you demonstrated in worked examples.
- Refer students whose abstracts have missing or incorrect elements back to one of the worked examples that most closely fits their research designs.

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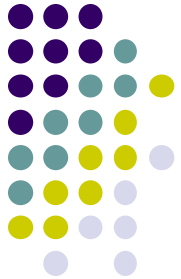

Which of these techniques might you adapt for your teaching?