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An Introduction to the

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Why Analogies?

Analogical thinking represents a fundamental way in which understandings of the world are **formed** and **communicated.**

Many **cognitive psychologists** suggest that

- Analogical thinking has practical benefits in activities such as
  1. **problem solving**
  2. **constructing explanations**
  3. **building arguments**

Why Analogies?

Psychologists also suggest that analogical thinking represents an efficient and effective way to

1. Sample **reasoning processes**
2. Measure
   - **verbal reasoning**
   - **inferential ability**
   - **analytical intelligence**

Why Analogies?

Psychologist **Robert Sternberg** suggests that solving analogies requires all of the information-processing components involved in **inductive reasoning**:

- **Encoding**—comprehending relevant information
- **Inference**—relating given concepts to other concepts
- **Mapping**—recognizing common shared rules
- **Application**—applying inferred rules to new concepts
- **Comparison**—choosing options that conform to ideals
- **Justification**—judging the reasonableness of choices
- **Response**—demonstrating choices

Why Analogies?

Based on a 2004 **meta-analysis** of the MAT, University of Minnesota psychology professor **Nathan Kuncel** and colleagues consider the MAT to

- represent an especially useful measure of **general cognitive ability**
- require both **reasoning with vocabulary** and **knowledge of various domains**
- involve all the **principles of cognition**
- represent a valid predictor of performance in both **academic** and **work** settings

Why Analogies?

MAT
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Practical Applications of Analogical Thinking

- **Education—**Conveying to students basic understandings of unfamiliar material
- **Science—**Developing, understanding, and evaluating scientific theories
- **Law—**Forming logical arguments based on the relevance of competing principals and precedents
- **Politics—**Comparing current situations to past situations as guidelines for action
- **Philosophy—**Explaining the nature of knowledge, reality, or human experience

Why Analogies?

Analogies as Metaphors
(nonliteral comparisons)

Some common metaphors

- An **eye** is like a **camera**.
- An **electric current** is like a **water circuit**.
- **Life** is a **journey**.
- An **opportunity** is like a **doorway**.

Conceptual metaphors in everyday human experience

- She **budgets her** time well.
- We have a lot of **ground to cover** today.
- His spirits **sank**.
- The time has **arrived**.

What is an Analogy?

An ***analogy*** is a way of showing that two situations share a **relational structure** by identifying a **sameness** in the relationship **despite surface differences**.

What is an Analogy?

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A MAT Analogy Item

One term in each MAT analogy item has been replaced with four answer options, only one of which is correct and forms a valid analogy:

PLANE : AIR :: CAR :

(*a*. motorcycle, *b*. engine, *c*. land, *d*. atmosphere)

What is an Analogy?

PLANE : AIR :: CAR :

(*a*. motorcycle, *b*. engine, *c*. land, *d*. atmosphere)

General Knowledge (Agent/Object)
In this type of analogy, one term causes, creates, provides, requires, uses, or in some other way relies on the other term. For this particular item, one term in each pair of terms "travels on" the other: A *plane* travels on *air*, just as a *car* travels on *land*.

Content Relevance

***Content validity*—**How adequately the content of a test represents a specified body of knowledge, and how adequately subjects' responses represent knowledge of the content.

MAT analogy items have been designed and constructed to measure:

- **cognitive skills** involved in recognizing analogical relationships
- **content knowledge** that American college students acquire through undergraduate general education and general reading and experience

Content Relevance

MAT Analogical Relationships	
Semantic (word meanings) 1. Similarity/Contrast 2. Intensity 3. Completion	***Association*** (ideas, objects, processes) 1. Object/Characteristic 2. Order 3. Agent/Object
Classification (classification, inclusion) 1. Category 2. Membership 3. Whole-Part/Part-Whole	***Nonsemantic*** (mathematical/logical) 1. Equality 2. Parts of Speech / Word Parts 3. Letter/Sound

Content Relevance

MAT Content Areas	
General Knowledge life experience, culture, work	***Mathematics*** algebra, arithmetic, finance, geometry, numbers, probability, statistics
Humanities art history, history, literature, languages, philosophy, music, visual arts	***Natural Sciences*** biological sciences, physical sciences, history of science
Language rhetoric, grammar, word meanings and connotations, word parts, pronunciations, and sounds	***Social Sciences*** economics, geography, political science, psychology, sociology

Content Relevance

A MAT Analogy Item from *General Knowledge*

PERGOLA : CARPENTER :: NAPOLEON :
(*a*. baker, *b*. general, *c*. lumber, *d*. trellis)

Association (Agent/Object)
A ***napoleon*** is a type of pastry made by a ***baker***, just as a wooden ***pergola*** is built by a ***carpenter***.

Content Relevance

A MAT Analogy Item from *Humanities*

POEM : (*a*. line, *b*. rhyme, *c*. stanza, *d*. sonnet) **::**
BOOK : CHAPTER

Classification (Whole/Part)
A ***stanza*** is a complete section of a ***poem,***
in the same way that a ***chapter*** is a complete
section of a ***book***.

Content Relevance

A MAT Analogy Item from *Language*

PRONUNCIATION : HOMOPHONE :: MEANING :
(*a*. articulation, *b*. principle, *c*. significance, *d*. synonym)

Language Association (Object/Characteristic)
One term in each pair of terms is a defining characteristic of the other: a ***homophone*** is one of two or more words that have the same ***pronunciation***, and a ***synonym*** is a word that has the same ***meaning*** as another word.

Content Relevance

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A MAT Analogy Item from *Mathematics*

$2^3 : 2^2 ::$ (*a*. 2, *b*. 4, *c*. 6, *d*. 8) **: 4**

Nonsemantic (Logical/Mathematical)
2 cubed equals ***8***, just as ***2 squared*** equals ***4***.
The values forming the analogy represent one number and its cube and another number and its square.

Content Relevance

A MAT Analogy Item from *Natural Sciences*

(*a*. cement, *b*. molten, *c*. sedimentary, *d*. volcano) :
IGNEOUS :: LIMESTONE : GRANITE

Classification (Category)
The pairs of terms forming the analogy have a member/class relationship: ***granite*** is an example of ***igneous*** rock, and ***limestone*** is an example of ***sedimentary*** rock.

Content Relevance

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A MAT Analogy Item from *Social Sciences*

TABLE : BILL :: (*a*. chair, *b*. direct, *c*. gesture, *d*. shelve) **: MOTION**

Association (Agent/Object)
To ***table*** a legislative ***bill*** is to delay consideration of it and, similarly, to delay consideration of a ***motion*** is to ***shelve*** it.

Predictive Validity

***Predictive validity*—**How well test scores predict graduate school grades, professor ratings, degrees awarded, departmental evaluations, or other indicators of subsequent success.

Predictive Validity of the MAT

Many studies have shown **positive correlations** between MAT scores and subsequent academic performance.

Predictive Validity

Predictive validity data for academic criteria included in meta-analyses by Kuncel, Hezlett, and Ones

- Kuncel, N. R, Hezlett, S. A., & Ones, D. S. (2004). Academic performance, career potential, creativity, and job performance: Can one construct predict them all? *Journal of Personality and Social Psychology, 86* (1), 148–161.
- Kuncel, N. R., Hezlett, S. A., & Ones, D. S. (2001). A comprehensive meta-analysis of the predictive validity of the Graduate Record Examinations: Implications for graduate student selection and performance. *Psychological Bulletin, 127* (1), 162–181.

Predictive Validity

Predictive Validity Data for Three Academic Criteria for the MAT, GRE® Verbal (V), GRE Quantitative (Q), and Undergraduate GPA (UGPA)

Criterion	MAT		GRE–V		GRE–Q		UGPA	
	r_{obs}	ρ	r_{obs}	ρ	r_{obs}	ρ	r_{obs}	ρ
1st-year Graduate GPA	0.29	0.41	0.24	0.34	0.24	0.38	0.30	0.33
Overall Graduate GPA	0.27	0.39	0.23	0.34	0.21	0.32	0.28	0.30
Comprehensive Exam Scores	0.47	0.58	0.34	0.44	0.19	0.26	0.12	0.12

Note. r_{obs} = Average sample size weighted observed correlation; ρ = Estimated true score validity for MAT, and estimated operational validity for GRE; adapted from Kuncel, Hezlett, & Ones (2001, 2004) by The Psychological Corporation.

Predictive Validity

Effect Size Magnitudes (*d*) of the Differences between MAT, GRE Verbal (V), GRE Quantitative (Q), and Undergraduate GPA (UGPA) Predictive Validity Statistics

Criterion	MAT / GRE–V *d*	MAT / GRE–Q *d*	MAT / UGPA *d*
1st-year Graduate GPA	**0.52**	0.22	**0.63**
Overall Graduate GPA	0.40	**0.82**	**0.90**
Comprehensive Exam Scores	**1.29**	**6.75**	**21.68**

Note. Adapted by The Psychological Corporation from Kuncel, Hezlett, & Ones (2001, 2004) estimated true score validity for MAT and estimated operational validity for GRE.

Predictive Validity

Evaluations of the differences between the predictive validity reported in the two meta-analysis studies show the MAT to be more predictive than either the GRE or undergraduate GPA.

- For first-year graduate GPA, the **MAT** is a **better predictor** than GRE Verbal or undergraduate GPA.
- For overall graduate GPA, the **MAT** is a **better predictor** than GRE Quantitative or undergraduate GPA.
- For comprehensive exam scores, the **MAT** is a **better predictor** than GRE Verbal, GRE Quantitative, or undergraduate GPA.

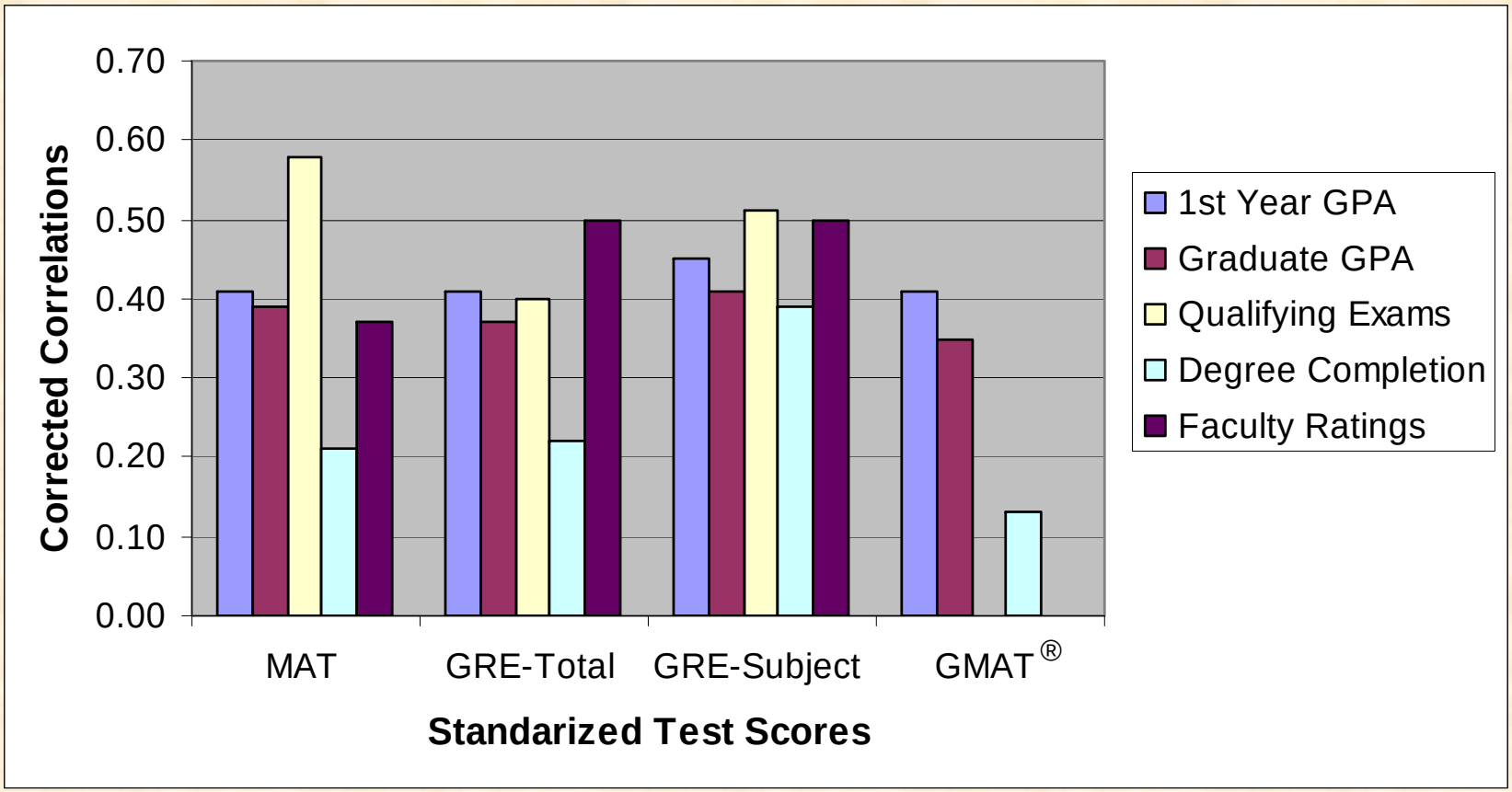
Predictive Validity

A recently published study that collected and synthesized data from several meta-analyses of standardized tests used in the United States for graduate admissions:

- Kuncel, N. R., & Hezlett, S. A. (2007). Standardized tests predict graduate students' success. *Science*, *315* (5815), 1080–1081.

Predictive Validity

Standardized Test Score Correlations with Student Success in Graduate School



Note. Adapted from Kuncel & Hezlett (2007) by The Psychological Corporation.

Predictive Validity

A **predictive validity study** conducted by The Psychological Corporation collected data from nine graduate schools for students entering programs in the fall of 2005:

- Undergraduate GPAs
- Previous graduate GPAs
- MAT scaled scores
- GRE scaled scores
- Demographic information
- GPAs for the first academic year in a graduate program (2005–06)

Predictive Validity

Entering Graduate Student Frequencies (*n*) and Variable Means for the Nine Participating Institutions

Entering Variable	*n*	Mean
MAT Scaled Score	513	413.0
GRE Verbal Scaled Score	437	492.9
GRE Quantitative Scaled Score	432	537.1
GRE Analytical Writing Score	326	4.49
Undergraduate GPA	639	3.24
Previous Graduate GPA	118	3.67

Predictive Validity

Correlations (*r*) Between Predictor Variables and 2005–06 GPA for All Cases

Predictor Variables for All Cases	*n*	2005–06 GPA *r*
MAT Scaled Score	513	0.27**
GRE Verbal Scaled Score	437	0.21**
GRE Quantitative Scaled Score	432	0.27**
GRE Analytical Writing Score	326	0.11
Undergraduate GPA	639	0.24**
Previous Graduate GPA	118	0.30**

Note. ** = Significant at 0.01 level

Predictive Validity

Correlations (*r*) Between Predictor Variables and 2005–06 GPA for Business Majors

Predictor Variables for Business Majors	*n*	2005–06 GPA *r*
MAT Scaled Score	141	0.29**
GRE Verbal Scaled Score	16	—
GRE Quantitative Scaled Score	12	—
GRE Analytical Writing Score	11	—
Undergraduate GPA	121	0.07
Previous Graduate GPA	6	—

Note. ** = Significant at 0.01 level

Predictive Validity

Correlations (*r*) Between Predictor Variables and 2005–06 GPA for Education Majors

Predictor Variables for Education Majors	*n*	2005–06 GPA *r*
MAT Scaled Score	211	0.15*
GRE Verbal Scaled Score	207	0.08
GRE Quantitative Scaled Score	207	0.15*
GRE Analytical Writing Score	181	0.02
Undergraduate GPA	300	0.21**
Previous Graduate GPA	85	0.06

Note. ** = Significant at 0.01 level; * = significant at 0.05 level.

Predictive Validity

Correlations (*r*) Between Predictor Variables and 2005–06 GPA for Social Science Majors

Predictor Variables for Social Science Majors	*n*	2005–06 GPA *r*
MAT Scaled Score	71	0.20
GRE Verbal Scaled Score	81	0.33**
GRE Quantitative Scaled Score	80	0.28*
GRE Analytical Writing Score	78	0.31**
Undergraduate GPA	76	0.02
Previous Graduate GPA	2	—

Note. ** = Significant at 0.01 level; * = significant at 0.05 level.

Predictive Validity

Entering MAT Scores		Predicted 1st Year Graduate GPA Earners	
SS	PR	Sensitivity	Specificity
406	61	62	60
407	62	66	57
408	63	66	55
409	64	69	54
410	65	69	52
411	66	69	49
412	67	69	48
413	71	69	46
414	72	69	45
415	73	69	44
416	74	72	42
417	75	76	40
418	76	76	39
419	77	79	37
420	78	79	35

Diagnostic Accuracy for Predicting First-Year Graduate GPAs from Entering MAT SS and PR (sample mean = 413)

Note. Sensitivity = percent of students likely to earn within the lowest 5% of GPAs in first year of graduate study (lower than 3.30)

Specificity = percent of students likely to earn within the highest 95% of GPAs in first year of graduate study (3.20 GPA or higher)

Predictive Validity

Conclusions of the Predictive Validity Study

- Adequate positive correlations between MAT scores and first-year graduate GPAs that are comparable to observed correlations found in the research literature
- Continuing usefulness of MAT scores as an important part of the admission process
- Importance of not establishing rigid MAT cut-scores, but always considering MAT scores along with as many other pieces of candidate information as possible when making admission decisions

Reliability

- **Internal Consistency**
  Analyzes of the degree of correlation among test item responses yields estimates of internal consistency that range from **0.89 to 0.93**.
- **Standard Error of Measurement (*SEM*)**
  Estimate of the possible amount of error present in a test score, range from **6.90 to 7.38**.
- Both reliability indicators suggest satisfactory reliability according to conventional practices.

MAT Administrations

The MAT is administered through a network of hundreds of **Controlled Testing Centers** that have been established at colleges and universities throughout the United States and Canada (as well as at a few overseas sites).

There are two test formats:

- Computer-based
- Paper-and-pencil

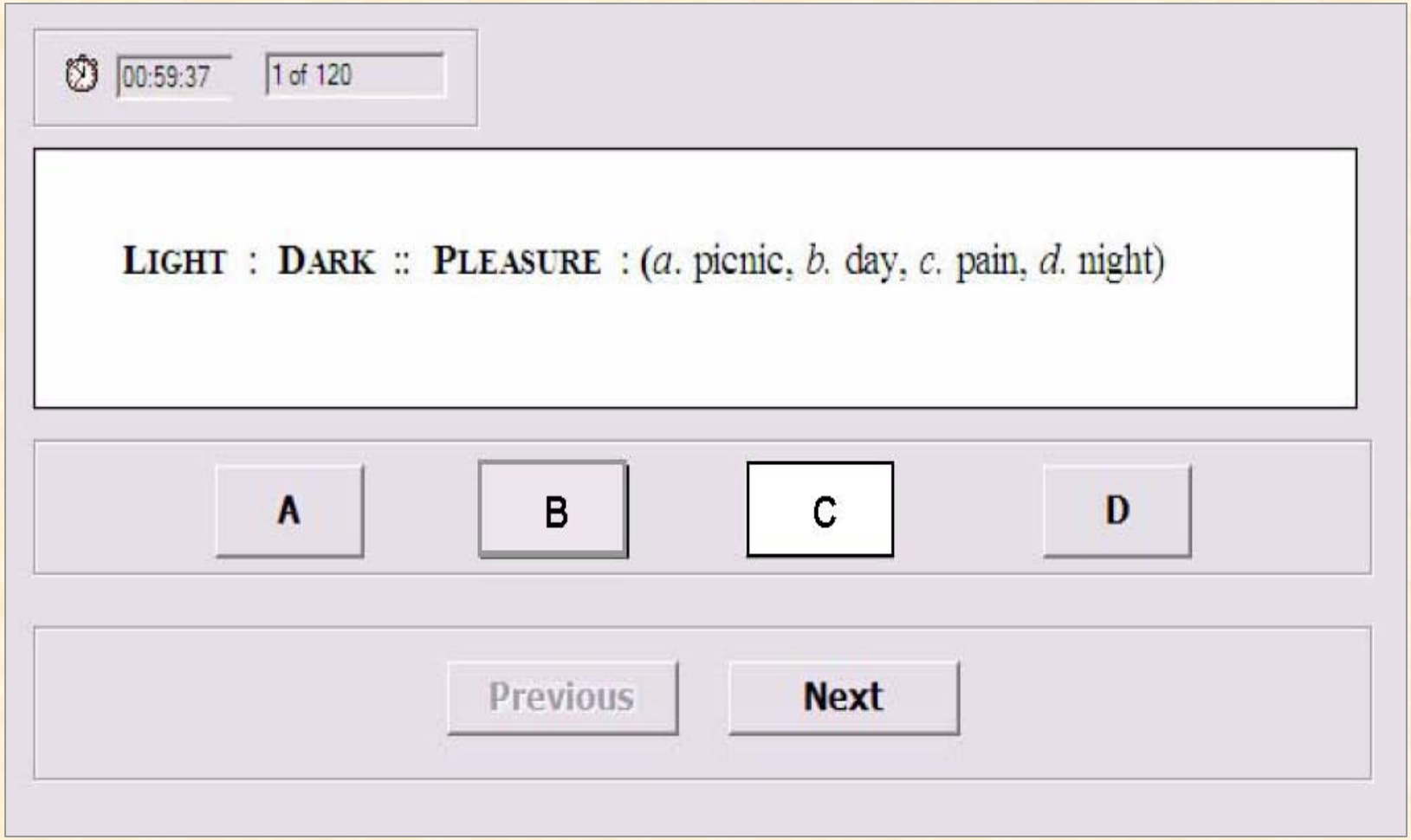
MAT Administrations

The Structure of the MAT

- Administered in 60 minutes
- Composed of 120 analogy items
  1. **100 core items** that count toward examinees' scores that are reported on personal Score Reports and on Official Transcripts
  2. **20 experimental items** being field-tested for possible use on future forms that do not count toward examinees' scores

MAT Administrations

Computer-Based Version of the MAT



MAT Scores

MAT Scaled Scores

- range from 200 to 600
- mean of 400
- standard deviation of 25

Percentile Ranks

- range from 1 to 99
- represent the proportion of examinees earning lower than a given scaled score

MAT Scores

Distribution of Scaled Scores by Intended Field of Study and Total Group for the 2001–2003 Normative Sample

Intended Field of Study and Total Group	*n*	Scaled Scores (SS)		
		M	*SD*	Observed SS Range
Business	8,280	396.5	25.3	237–511
Education	75,130	399.9	24.2	233–547
Humanities	2,967	413.7	26.2	326–547
Natural Sciences	7,614	402.8	22.8	331–529
Social Sciences	11,535	398.8	26.0	235–513
Other	19,880	400.0	27.0	231–563
Undecided	676	399.4	27.0	320–506
Total Group	126,082	400.0	25.0	231–563

MAT Scores

Preliminary Score Report: Unofficial scores available to examinees taking a computer-based version of the MAT

Personal Score Report: Mailed to each examinee

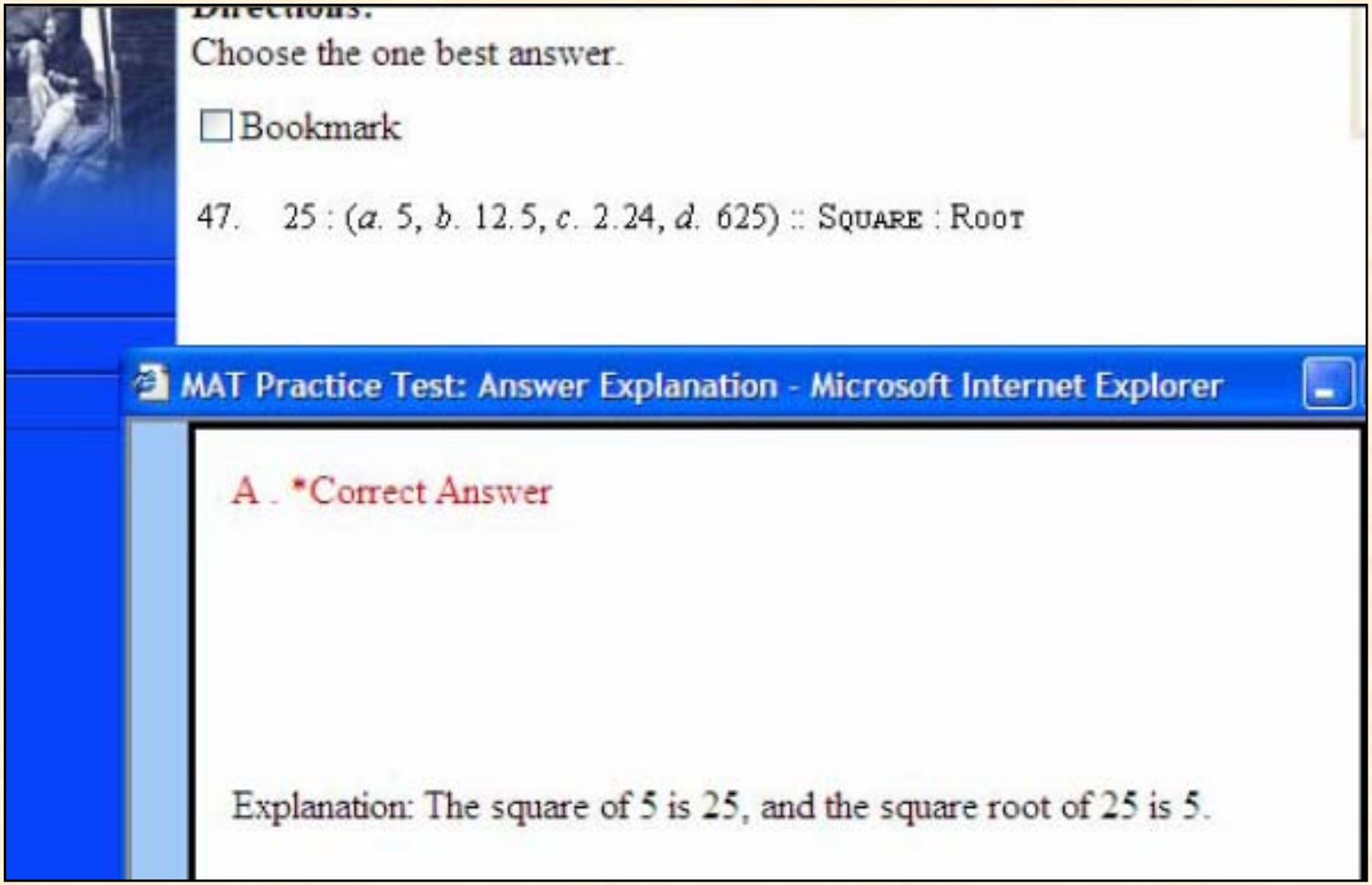
Official Transcript: Sent to institutions and organizations requested by the examinee showing all MAT scores earned within the previous five years

Test Preparation

- MAT **Candidate Information Booklet**, with sample items, explanations, and strategies
- Two **Practice Tests** available on the MAT website, **www.milleranalogies.com**
  1. **100 analogy items** like those on the actual MAT
  2. **Score Report** with simulated percentile rank scores
  3. **$23.99 fee** for each Practice Test payable by credit card

Test Preparation

Online Practice Test



Future Plans

- Continuous development of **new computer-based test forms**
- **Renorm** the MAT as often as necessary to maintain score stability; possibly as soon as 2009
- Development of **new online Practice Tests** for 2009

An Introduction to the *Miller Analogies Test*

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