Alberta

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Grade 9 Mathematics

Provincial Achievement Test

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Government of Alberta

Education

Overview of Session

- What is the purpose of the Provincial Achievement Testing Program
- How is the data from the Provincial Achievement Tests (PATs) used?
- How is the Mathematics 9 PAT designed?
- What kinds of questions will be on the Math 9 PAT?
- How did students do on the 2011 Math 9 PAT?
- What can I do to ensure my students are ready for the Math 9 PAT?
- How can I get involved in the provincial achievement test development process?

Purposes of Achievement Testing Program

- **Students/parents:** to provide feedback on how well the students have understood the learning outcomes from the Alberta K-6 Mathematics Program of Studies with Achievement Indicators (2007).
- **Teachers:** to provide information on how well their classes have achieved, permit comparison of their assessment information to these test results, and provide some feedback on instructional practice.

- **Principals**: to provide information on school achievement patterns in relation to provincial results and other information on achievement for reporting the school's annual results and for program planning and future goal setting.
- **Superintendents/trustees**: to provide information regarding jurisdiction results in relation to targets and provincial results for the jurisdiction 3 year education plan.

Alberta Education and Government: to provide information for monitoring student learning of selected curricular knowledge and skills in relation to provincial targets and to identify areas for improvement through curriculum redesign or program initiatives.

How is the data from the Provincial Achievement Tests used?

Information for students and their parents:

- ✓ Individual Student Profiles(ISPs).
- ✓ One copy is placed in each student's cumulative file and one copy of the ISP is sent to each student's parent(s).

PAT information video for parents:

http://education.alberta.ca/parents/resources/exams.aspx

Information for teachers:

- ✓ Provides information on how well students have performed in relation to specific outcomes from the program of studies.
- ✓ Provides an opportunity to compare classroom/school assessment data to provincial data.

Information for principals :

- ✓ Provides information on school achievement patterns in relation to provincial results.
- ✓ Provides information on achievement for reporting the school's annual results.
- ✓ Provides information to assist with program planning and future goal setting.

Information for Superintendents/trustees:

- ✓ Provides information regarding jurisdiction results in relation to their achievement targets (the percentage of students they expect to achieve acceptable and excellent standards).
- ✓ Provides provincial results for the jurisdiction 3 year education plan.

- **Information for Alberta Education and Government:**

✓ Provides information for monitoring student learning of selected curricular knowledge and skills in relation to provincial targets (business plan).

✓ Helps to identify areas for improvement through curriculum redesign or program initiatives.

✓ Part of the Accountability Pillar report.

Transparency is Essential to Improvement

“…there is no way that continuous improvement can occur without constant transparency fueled by good data.”

Michael Fullan

How are the Mathematics Achievement Tests designed?

Overview of the Test Design Process

The Test Specifications of the Mathematics 9 PAT

The information in the “front matter” of the curriculum and the content of the Specific Outcomes were both considered as the test blueprint was being developed.

Teachers determined the weighting of the test according to:

1. Strand (N; PR; SS; SP)
2. Item complexity
3. Item format (# of MC and NR items)
4. Specific outcome representation

Specific Teacher Involvement in the creation of the Test Specifications for the Mathematics 9 PAT

- July of 2009: test-blueprinting session resulting in the blueprint for the 2010 Math Pilots. One of the results was the introduction of 4 more10 NR items.
- July of 2011: teachers went through the same process which created a slight change to the test blueprint. (Incidentally, teachers recommended the inclusion of even more NR items.)
- July/August of 2011: the standards (cut-scores) were set.
- July/August of 2012: teachers will set the standards for the 2012 test.

Blueprint for the Grade 9 Mathematics Achievement Test (Revised for 2011)

Multiple Choice (MC) and Numerical Response (NR)			
Item Type	**Number of Items**	**Number of Marks**	**Percentage of Test**
MC	40	40	80%
NR	10	10	20%
Total	50	50	100%

Content Domain of Test	
Strand	**Percentage of Items on Test**
Number	25 – 35%
Patterns and Relations	35 – 45%
Shape and Space	20 – 30%
Statistics and Probability	5 – 10%

Cognitive Domain of Test	
Complexity Level	**Percentage of Items on Test**
Low	30 – 40%
Moderate	45 – 55%
High	10 – 20%

What kinds of questions will be on the PAT?

General Characteristics of PAT Questions:

1. Reflect the intent and direction given in the front matter.
2. Assess one or more strands and/or specific outcomes.
3. Are at an appropriate reading level.
4. Use a context applicable to students.
5. Meet the criteria for an effectively constructed multiple choice question.
7. Are statistically valid.

   (Difficulty between .300 and .900, CRPB that is positive)

Research regarding Multiple Choice Questions

"Test developers need not apologize for using multiple-choice formats on achievement tests; there is strong research evidence demonstrating the high positive correlation between constructed-response and selected-response item scores for measuring knowledge and many other cognitive skills." (Rodriguez, 2003)

Item	*Key*	*Level of Complexity*	*Strand*	*Item Descriptor*	*Diff.*	*CRPB*
1011_11	B	M	N.9.1	Add three-digit numbers that are represented pictorially with base-ten blocks. (Also N.5)	.500	.336

This item meets all the major standards

MC Item #11	GROUP	N	NR	NF	OMIT	A	B*	C	D
Dif: 0.500	Total:	442	14	0	14	0.118	0.500	0.219	0.131
Rpb: 0.402	High:	119	2			0.034	0.824	0.042	0.084
Crpb:0.336	Mid:	193	7			0.114	0.446	0.249	0.155
95% Con:	Low:	130	5			0.200	0.285	0.338	0.138
	Test Score Means:					16.192	22.452	16.526	18.569
Rbis: 0.502									
Crbis: 0.420	Discriminating Power:					-0.166	-0.539	-0.296	-0.054
Iri: 0.201	Standard Error of D.P.:					0.005	0.000	0.006	0.005

Low-Complexity Questions

These questions typically require students to recall and/or recognize basic mathematical concepts and procedures. Students are not expected to come up with original methods for finding a particular solution.

Low-complexity questions require students to:

- Recall a basic fact, term or definition
- Perform a specific procedure (+, -, x, ÷)
- Solve a one-step or simple two-step problem
- Identify an example of a concept
- Determine an unknown number in an equation or expression
- Draw, measure, or describe a 2-D shape or 3-D object
- Retrieve information from a graph, table, or figure

Item	Question # on PAT	Strand	Primary Outcome Number	Item Complexity	% of Student Responses			
					A*	B	C	D
5	6	PR	5	Low	60.1	24.3	8.7	6.8

*** Correct response**

6. Which of the following expressions is equivalent to $-(3x-2)$?

A. $-3x+2$

B. $-3x-2$

C. $3x+2$

D. $3x-2$

To answer this item correctly, students had to correctly multiply a monomial and a polynomial expression. Not being able to perform this relatively simple operation would hinder a student's ability to solve more complex equations.

The most common incorrect response (B) suggests that some students applied the negative monomial only to the first term of the polynomial expression. The second most common incorrect response (C) suggests that some students applied the negative monomial only to the second term of the polynomial, or applied it to both terms but forgot to include the negative sign on the first term.

Moderate-Complexity Questions

These questions typically involve more flexibility of thinking than those in the low-complexity category. They require a response that goes beyond the habitual and may involve more than a single step. The student is expected to decide what to do, to use reasoning and problem-solving strategies, and to bring together their skills and knowledge in order to find a solution.

Moderate-complexity questions require students to:

- Solve a word problem requiring multiple steps
- Compare patterns, data, or equations
- Provide or recognize justification for a solution process
- Interpret a concrete, pictorial, or symbolic representation
- Retrieve information from a graph and use it when solving a multi-step problem
- Formulate a generalization about one or more objects or patterns

Item	Question # on PAT	Strand	Primary Outcome Number	Item Complexity	% of Student Responses			
					A	B	C	D*
4	32	N	3	Moderate	7.0	5.2	12.9	74.7

*** Correct response**

Use the following information to answer question 32.

The following list shows Rick's yearly vehicle expenses.

- Insurance: $1 200
- Gasoline: $1 300
- Repairs: $850

32. If Rick works 8 hours/day, 5 days/week, and takes home $10/hour, then what is the **least** number of complete weeks he must work in order to pay for all his yearly vehicle expenses?

A. 6 weeks

B. 7 weeks

C. 8 weeks

D. 9 weeks

To answer this item correctly, students had to correctly solve a contextual problem involving money by applying arithmetic operations on rational numbers.

The most common incorrect response (C) suggests that some students completed the required arithmetic operations correctly but simply applied rounding rules instead of applying mathematical reasoning to make sense of their solution.

High-Complexity Questions

These questions typically require students to engage in more abstract reasoning, planning, analysis, judgment, and creative thought.

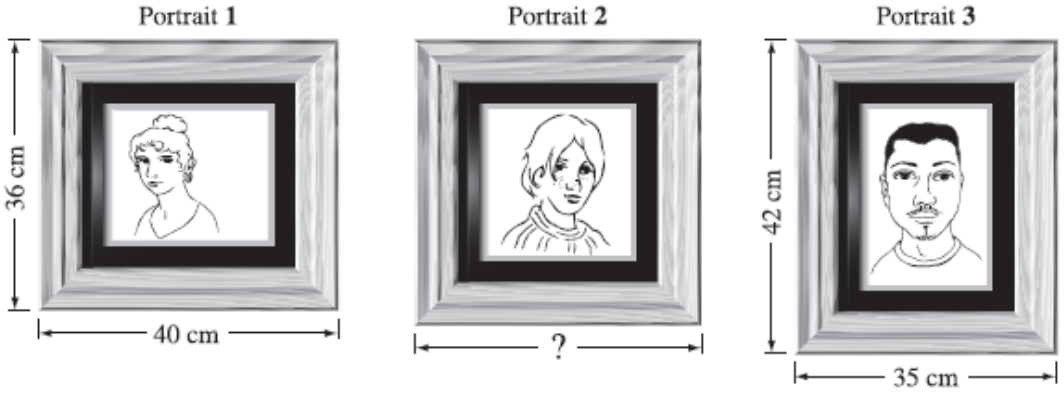
High-complexity questions require students to:

- Perform a procedure which has multiple steps and multiple decision points
- Analyze similarities and differences between procedures and concepts
- Formulate an original problem
- Solve a problem in more than one way
- Explain and justify a solution to a problem
- Describe, compare, and contrast solution processes
- Provide a mathematical justification

Item	Question # on PAT	Strand	Primary Outcome Number	Item Complexity	Percentage of Students Selecting Each Option	
					Correct	Incorrect
7	NR 6	N	6	High	53.7	46.3

Use the following information to answer numerical-response question 6.

Pat arranges three portraits from smallest to largest based on area. Portrait 2 is square, and its side length, measured in centimetres, is a whole number.



Numerical Response

6. The side length of portrait 2 is _____ cm.

(Record your answer in the numerical-response section on the answer sheet.)

To answer this item correctly, students had to correctly find the perfect square between two non-perfect squares.

Of incorrect student responses, 73.8% provided answers between 35 and 40, suggesting that they did not understand that the portraits were arranged in order according to area.

Before a question is used on a PAT the following questions must be addressed:

Does the question have curricular validity?

Each question must be based on the outcomes in the program of studies.

Does the question have instructional validity?

Questions, particularly process questions, should relate to the instructional focus as well as to the program of studies.

How did students do on the Grade 9 2011 Mathematics Achievement Test?

Table 2.2
Standards Achieved by Students Writing the Test

Reporting Category	Maximum Possible Score	Cut Score[a]	School n = 99		Province n = 35660	
			Number	Percent	Number	Percent
Acceptable Standard[b]						
Total Test	50	27	**65**	**65.7**	26095	73.2
Standard of Excellence						
Total Test	50	44	**11**	**11.1**	6888	19.3
Below Acceptable Standard						
Total Test	50	N/A	**34**	**34.3**	9565	26.8

[a] The Cut Score is the lowest score on a test, determined by standard-setting procedures, that students must achieve for their performance to be judged "acceptable" and/or "excellent" in relation to provincial expectations.

[b] The Acceptable Standard includes students who achieved the Standard of Excellence.

Note: Results should be compared to your school and school authority targets.

Table 4
Raw Score Results, by Reporting Category and by Gender [a]

Reporting Category	Maximum Possible Score	School						Province					
		All Students n = 99		Female n = 40		Male n = 59		All Students n = 35656		Female n = 17207		Male n = 18449	
		Average	S. D. [b]	Average	S. D.	Average	S. D.	Average	S. D.	Average	S. D.	Average	S. D.
Total Test	50	**30.6**	**10.0**	**30.2**	**10.3**	**30.9**	**9.9**	33.3	10.3	33.3	10.2	33.3	10.4
Multiple Choice	40	**25.8**	**7.9**	**25.5**	**8.0**	**26.0**	**7.8**	27.6	7.8	27.7	7.7	27.6	7.9
Numeric Response	10	**4.8**	**2.6**	**4.7**	**2.7**	**4.9**	**2.5**	5.6	2.9	5.6	2.9	5.7	2.8
LOC - Low [c]	18	**11.4**	**4.0**	**11.4**	**3.9**	**11.5**	**4.0**	12.5	3.9	12.6	3.8	12.5	4.0
LOC - Moderate	21	**13.3**	**4.3**	**13.0**	**4.6**	**13.5**	**4.2**	14.1	4.4	14.1	4.4	14.1	4.5
LOC - High	11	**5.9**	**2.5**	**5.8**	**2.5**	**6.0**	**2.5**	6.6	2.7	6.6	2.7	6.7	2.7
Number	16	**10.0**	**3.8**	**9.7**	**3.9**	**10.3**	**3.8**	10.8	3.8	10.8	3.8	10.8	3.8
Patterns & Relations	17	**10.5**	**3.6**	**10.4**	**3.7**	**10.5**	**3.6**	11.4	3.7	11.4	3.6	11.4	3.7
Shape & Space	12	**6.6**	**2.8**	**6.5**	**2.9**	**6.7**	**2.8**	7.3	2.9	7.3	2.9	7.4	2.9
Statistics & Probability	5	**3.5**	**1.1**	**3.6**	**1.1**	**3.5**	**1.1**	3.8	1.1	3.8	1.1	3.7	1.1

[a] Students for whom gender information is not available are included in the "All Students" column only.

[b] Standard Deviation - The standard deviation is an indication of the amount of variation in a distribution. Provincially, about 68% of the students' marks will fall within plus or minus one "standard deviation" of the average mark.

[c] Level of Complexity – Refers to the cognitive demand associated with an item: Low, Moderate, and High. Please refer to the "Mathematics 9 Subject Information Bulletin" for more information regarding item complexity.

Table 5 - 1
Results for Individual Multiple-Choice and Numeric-Response (NR) Items, by Reporting Category

Item #	% Correct Sch.	% Correct Prov.	Specific Outcome	Complexity	Item Description
2	**69.7**	74.9	N.3	Low	Perform arithmetic operations on rational numbers that are in fraction form
11	**56.6**	70.0	N.2	Low	Determine the sum, difference, product, and quotient of given powers with integral bases and whole number exponents
20	**46.5**	58.2	N.2	Low	Simplify an expression contained within parentheses by applying the exponent laws of powers with integral bases and whole number exponents
30	**64.6**	71.0	N.6	Low	Estimate the square root of a given rational number that is not a perfect square using the roots of perfect squares as benchmarks (Gr.8, N.2)
NR10	**57.6**	52.9	N.5	Low	Determine the number of perfect squares that are between two given numbers (Gr.8, N.1-2)
9	**67.7**	73.0	N.1	Moderate	Determine the symbolic or pictorial representation of a given a power that has an integral base and a whole number exponent
23	**58.6**	59.2	N.3	Moderate	Solve a given problem involving operations on rational numbers in fraction and decimal form (Gr.8, N.6)
24	**55.6**	64.7	N.2	Moderate	Perform operations on expressions containing powers with integral bases and whole number exponents
26	**57.6**	59.4	N.3	Moderate	Order a set of rational numbers given in fraction and decimal form (Gr.7,N.4; Gr.7,N.7; Gr.6,N.7)
32	**67.7**	74.3	N.3	Moderate	Solve a word problem involving arithmetic operations on rational numbers (Gr.8, N.7; Gr.7, N.2; Gr.6, N.2)

Strand

N - Number
PR - Patterns & Relations
SS - Shape & Space
SP - Statistics & Probability

Table 6
Results on 2010 and 2011 Items [a]

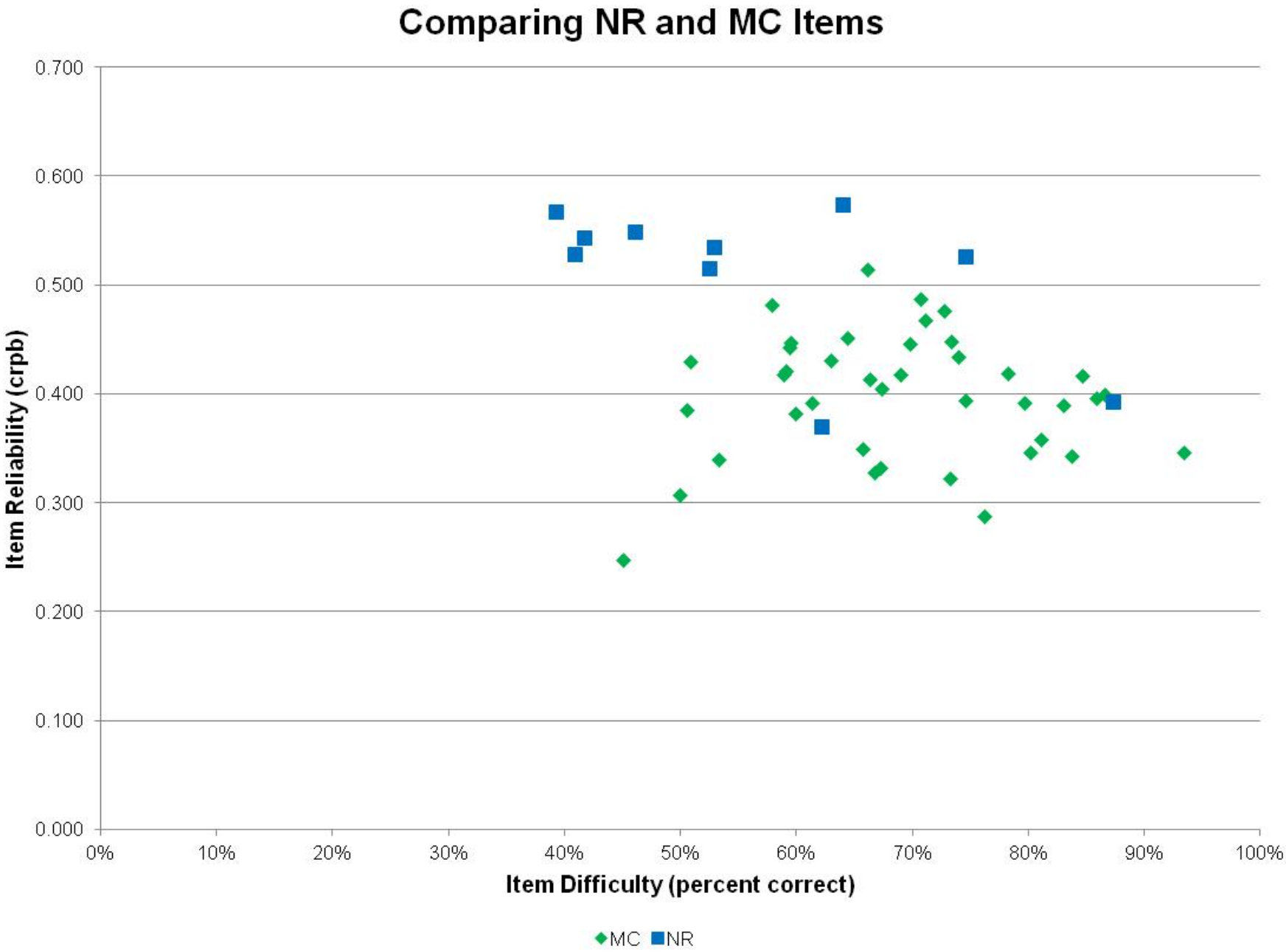
	2010 Achievement Test			2011 Achievement Test		
	No. of Items	School Average n = **N/A**	Provincial Average n = N/A	No. of Items	School Average n = **N/A**	Provincial Average n = N/A
Common Items: Items appearing on both the 2010 and 2011 tests	N/A	**N/A**	N/A	N/A	**N/A**	N/A
Unique Items: Items appearing on only the 2010 or the 2011 tests, but not on both	N/A	**N/A**	N/A	N/A	**N/A**	N/A

[a] This test was administered for the first time in 2011. As such, common and unique item performance reporting is not applicable.

Performance on MC vs. NR Items (2011 Math 9 PAT)

Mean on MC test items:	69.2%
Mean on NR test items:	56.7%

Mean CRPB on MC test items:	0.395
Mean CRPB on NR test items:	0.506


Comparing NR and MC Items
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Item Reliability (crpb)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Item Difficulty (percent correct)
MC
NR

What can I do to ensure that my students are ready for the PAT?

Balanced Assessment

A balanced assessment approach is an integration of classroom assessments, jurisdictional assessments, and provincial assessments into a unified process that benefits instruction and student learning. (Rick Stiggins, 2008)

Effective instructional and assessment practices is essential

- Use formative and summative assessment practices to monitor how well your students understand the curricular outcomes.
- Provide many different types of opportunities for your students to communicate their learning.
- Make problem solving the focus of the mathematical experiences in your classroom.

Participate in Field Testing:

• Three unit tests in grades 9 – Number, Patterns & Relations, and Shape & Space. These tests are available ONLY online, and can be administered at a time deemed appropriate by a teacher. (The same field-testing application process applies to these field tests as for all other field tests.)

• Stage 1 end-of-year field tests in both grades – these are field tests comprised only of NR items (-20 items on each test). These tests are available ONLY online. (The same field-testing application process applies to these field tests as for all other field tests.)

• End-of-Year Field tests administered in May/June. These tests can be done on-line or as paper/pencil tests.

What's New for the Math 9 PAT?

INSTRUCTION PAGES

Can be downloaded from a link that is beside the link to the Subject Bulletin link – Grade 9

ANSWER SHEETS

A sample answer sheet has been provided in the Subject Bulletin: Math 9

How do I find support materials for assessment?

1. **Assessment Highlights**
http://education.alberta.ca/admin/testing/achievement/highlights.aspx

2. **Mathematics Subject Bulletin**
http://education.alberta.ca/admin/testing/achievement/bulletins.aspx

3. **Previously Released Examinations and Quest A+**
http://education.alberta.ca/admin/testing/achievement.aspx

4. **A Guide for Teachers – Grade 3 Mathematics 2010-2011**
http://education.alberta.ca/admin/testing/achievement.aspx

Other support materials for instruction are available?

1. **Mathematics Program of Studies**
http://education.alberta.ca/teachers/program/math/educator/progstudy.aspx

2. **Authorized Resources**
http://education.alberta.ca/teachers/program/math/educator/resources.aspx

3. **Support Materials**
http://education.alberta.ca/teachers/program/math/educator/materials.aspx

4. **FAQs for Educators**
http://education.alberta.ca/teachers/program/math/educator/faq.aspx

5. **Fact Sheets and Useful Links**
http://education.alberta.ca/teachers/program/math/educator/links.aspx

6. **LearnAlberta.ca**
http://www.learnalberta.ca/Home.aspx?lang=en

How can I get involved in the provincial achievement test development process?

OPPORTUNITIES FOR INVOLVEMENT

1. Classroom Field Testing
2. Summer Marking (ELA and FLA)
3. Standard Setting Working Group
4. Technical Advisory Groups
5. Item Writing Groups

Questions and Answers

we engage
engager