Mathematics Background Questionnaire

Some Preliminary Survey Results for Introductory Calculus at McMaster University

Introduction and Background

- This is a project by graduate student Marcella Fioroni, a M.Sc. candidate at McMaster University (supervisor Dr. Miroslav Lovric)
- The Mathematics Background Questionnaire ("the survey") was created and administered by Dr. Miroslav Lovric, originally as a diagnostic tool.
- Results of the survey were found to have information that is useful for research in Mathematics Education

Demographic Information

- Each year we obtained a sample size of roughly 200-300 participants from a class of approximately 1500 students

  (a representative sample size)

- In the first part of the survey, students were asked for demographic information

Name (please print): _____

A Student No.: _____ Faculty: _____

MATHEMATICS BACKGROUND QUESTIONNAIRE 2006

The information you are sharing will be used to gain information on your high school mathematics background. It will help your mathematics instructor better plan and design the calculus course. Your responses will be kept confidential and will never be reported individually. **Thank you for taking the time to complete this questionnaire.**

- Your gender: _____ Age (years and months): _____
- How many years did you go to high school? What high school(s) did you attend (for each school, list: name, location (city and country), and for how long you attended it)

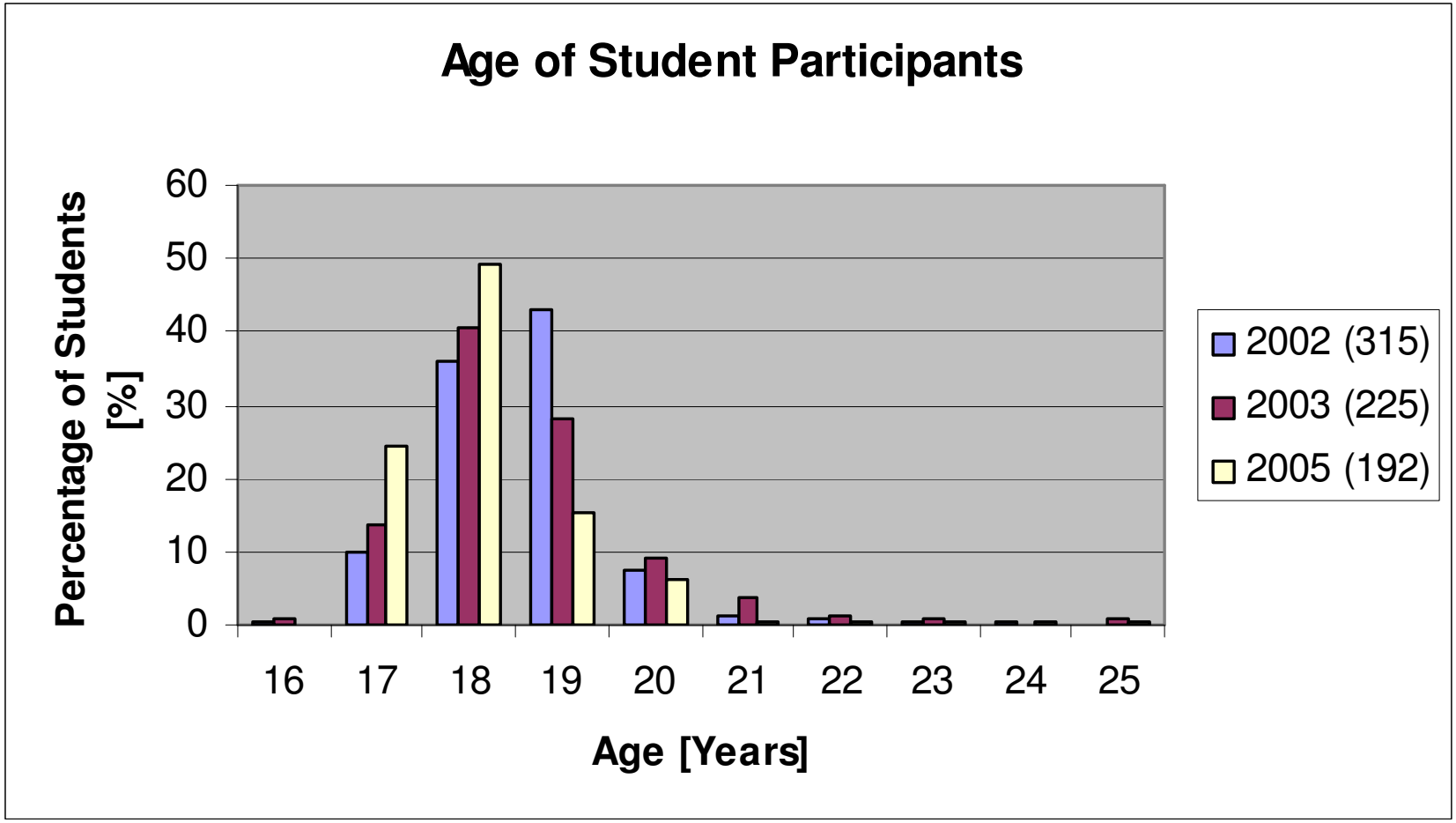
- Your high school math marks. Indicate the marks that you got for the courses below. If you do not remember the mark, write 'yes' instead.

Advanced Functions and Introductory Calculus U: _____

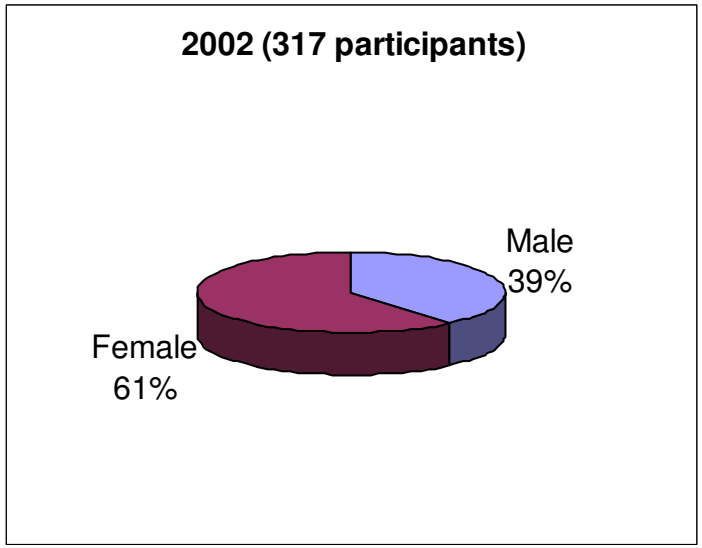
Geometry and Discrete Math U: _____ Mathematics of Data Management U: _____

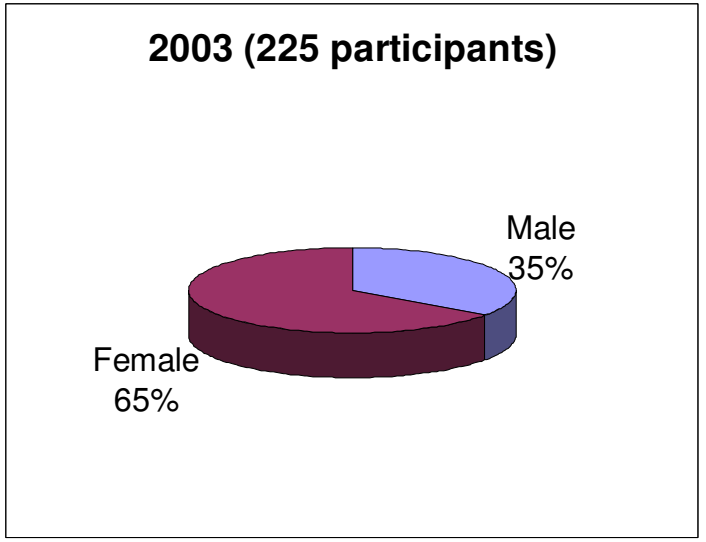
If you took courses not listed above in your final year in high school, give their name(s) and marks you got:

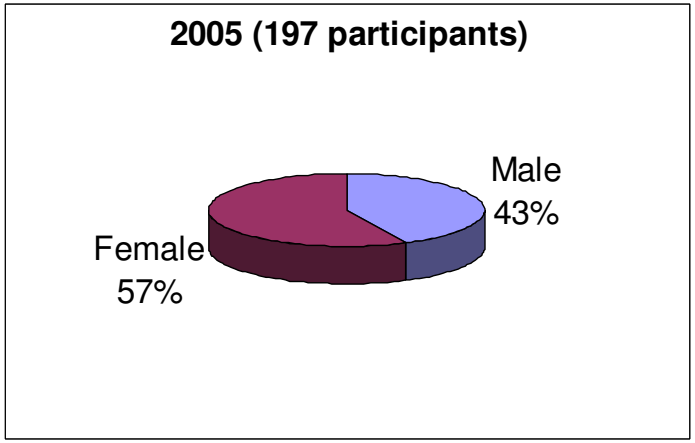
- What language do you speak most often in your parental home(s)?


Age of Student Participants
Percentage of Students [%]
60
50
40
30
20
10
0
16
17
18
19
20
21
22
23
24
25
Age [Years]
2002 (315)
2003 (225)
2005 (192)

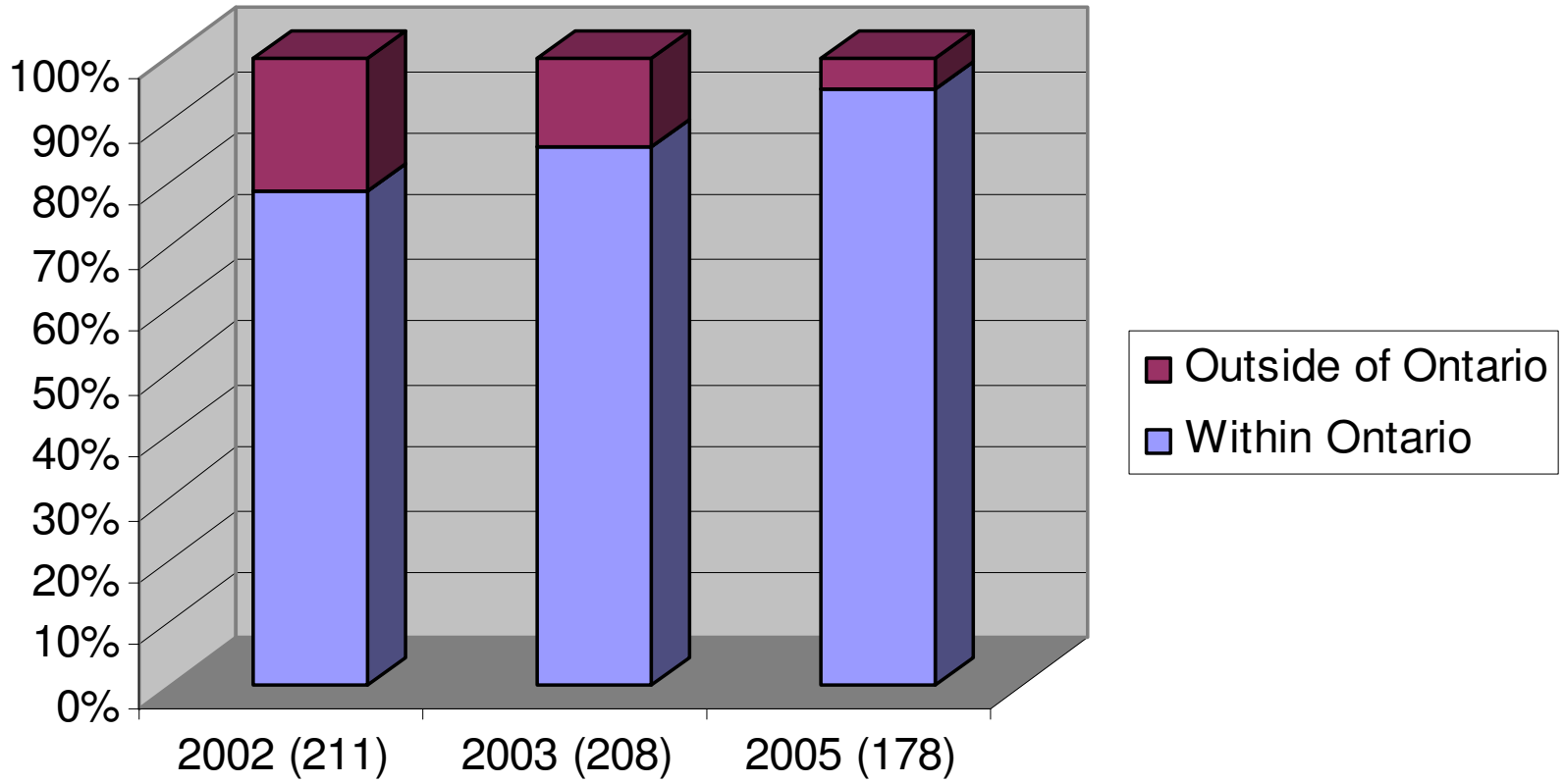
Gender of Student Participants



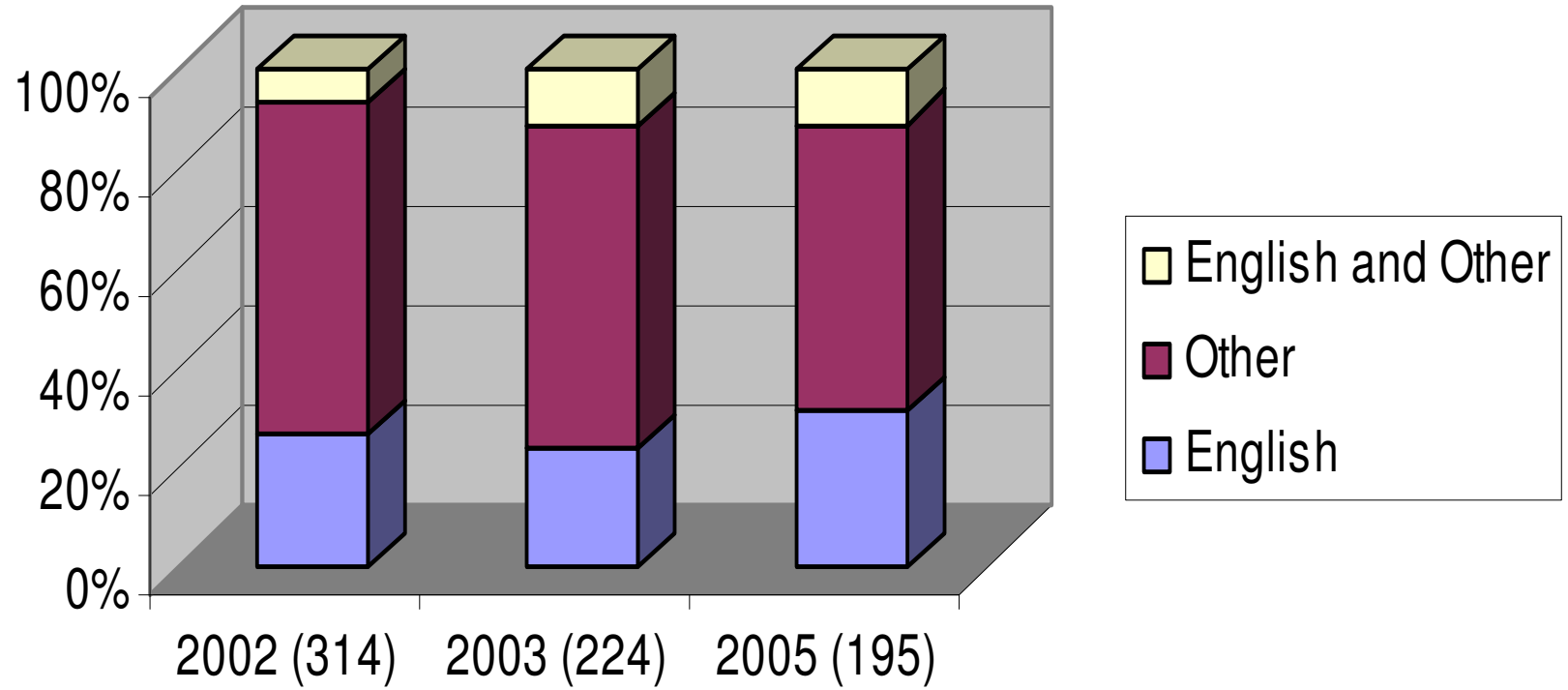




Student Participants Who Attended High School Within and Outside of Ontario



Language Spoken in Parental Homes of Student Participants



Purpose

The purpose of this project is two-fold. We will:

- analyze survey results in light of the recent High School curriculum changes in grade 12 mathematics.
- correlate survey results with students' final grade in the course.

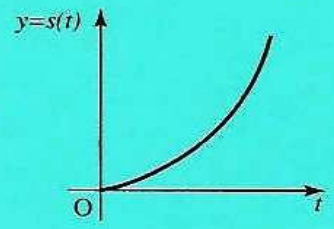
Correlation

- Students taking only 1 math course in high school on average scored 53.16% in first year Calculus
- Students taking 2 math courses in high school on average scored 66.26% in first year Calculus
  - Calc/Alg combo: 69.49%
  - Calc/Finite or Calc/Data combo: 63.02%
- Students taking all 3 high school math courses on average scored 74.66% in first year Calculus

Focus

- The survey contains 12 math problems.
- For this project, we focus on one particular survey question.

6. A position function $y = s(t)$ is given below.



(a) Describe the velocity $v(t)$ as increasing or decreasing. Explain how you know.

(b) Is the acceleration $a(t)$ positive or negative? Explain how you know.

Focus

This question was chosen because:

- it is conceptual (not procedural) in nature.
- it should reflect changes made in the High School Mathematics curriculum in 2000 (it is an applications problem and requires communication of a mathematical idea).

Grading Scheme

- Questions were graded both numerically and by letter code.
- Numeric scores ranged from 0 to 5. Letter codes were assigned from P, G, B, R, M, S, I, V, D, T.

Sample Answers

"V(t) is increasing seeing as the slope of the tangent is increasing" (2003, 5BT)

"Increasing because the slope is increasing" (2005, 4B)

"Use pretend equation $s(t)=x^2$, therefore $v(t)=2x$. Therefore velocity is increasing because the slope is increasing and slope indicates velocity" (2002, 4BG)

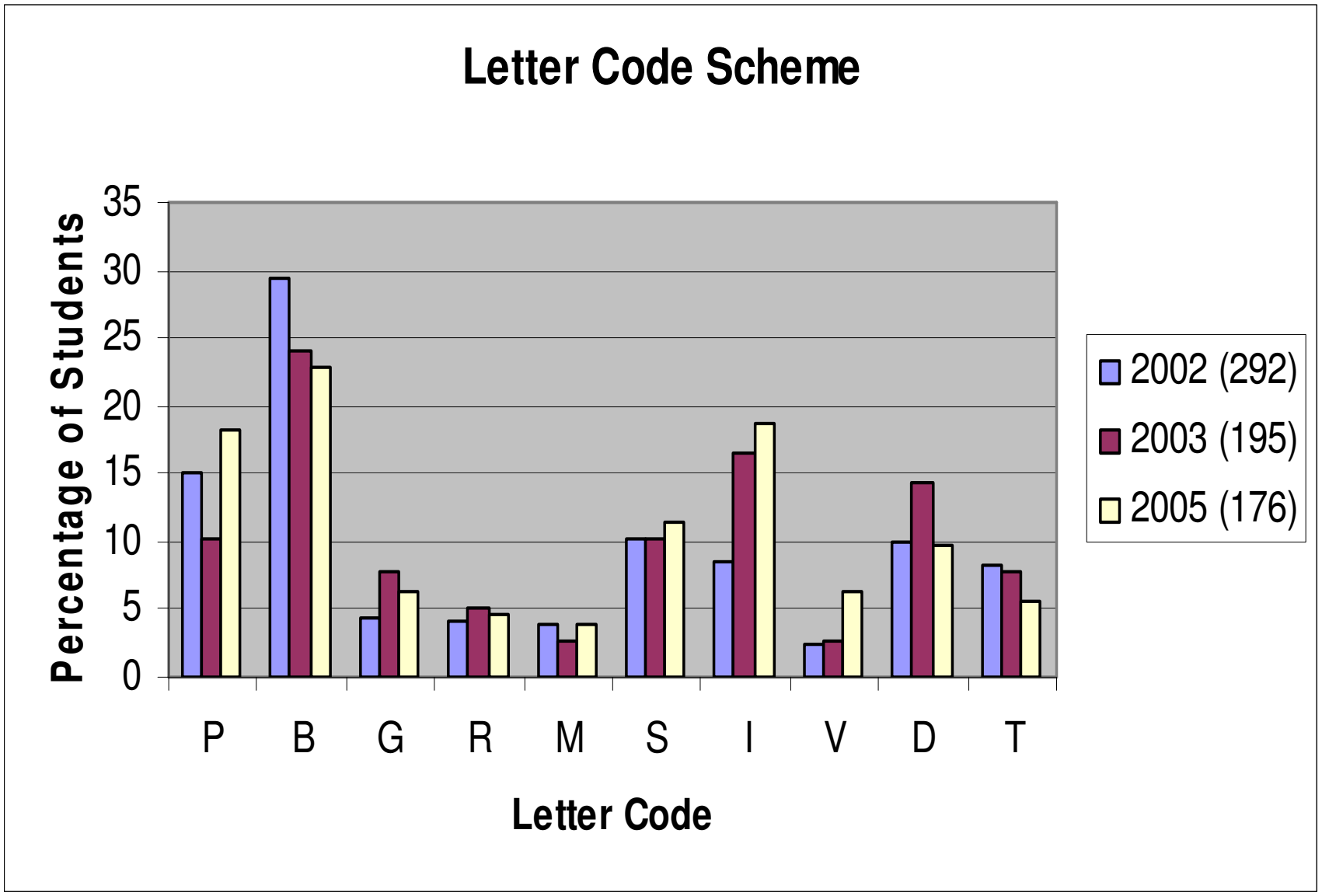
Sample Answers

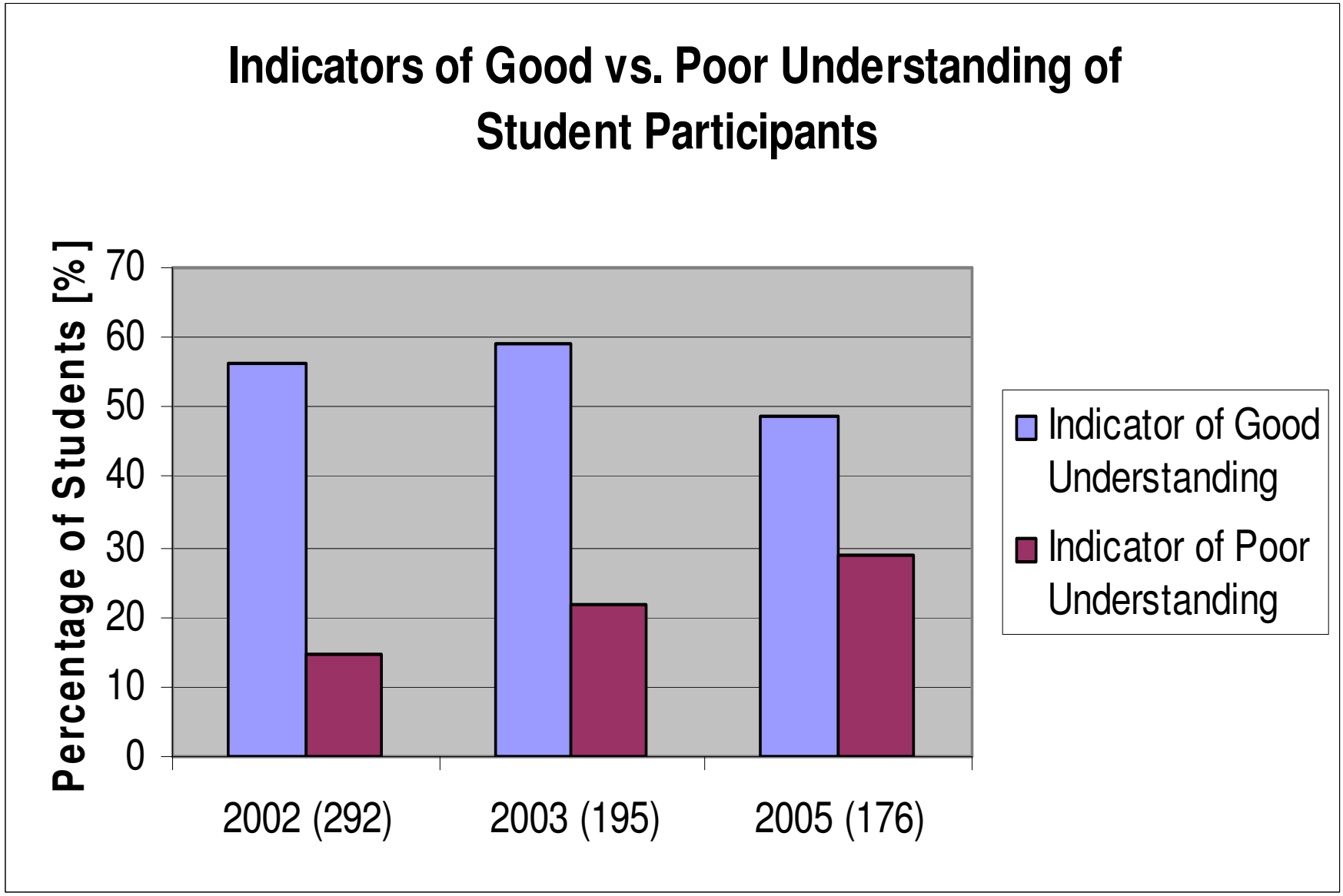
"Take first derivative it is increasing" (2003, 3D)

"Let x1<x2 and they are any number in the domain. We can see y2>y1 from the graph. So, the velocity is increasing." (2003, 2I)

"Velocity is increasing because the slope of the tangent line is positive" (2003, 2ST)

"The velocity is increasing because as time increases, the velocity increases" (2005, 2V)

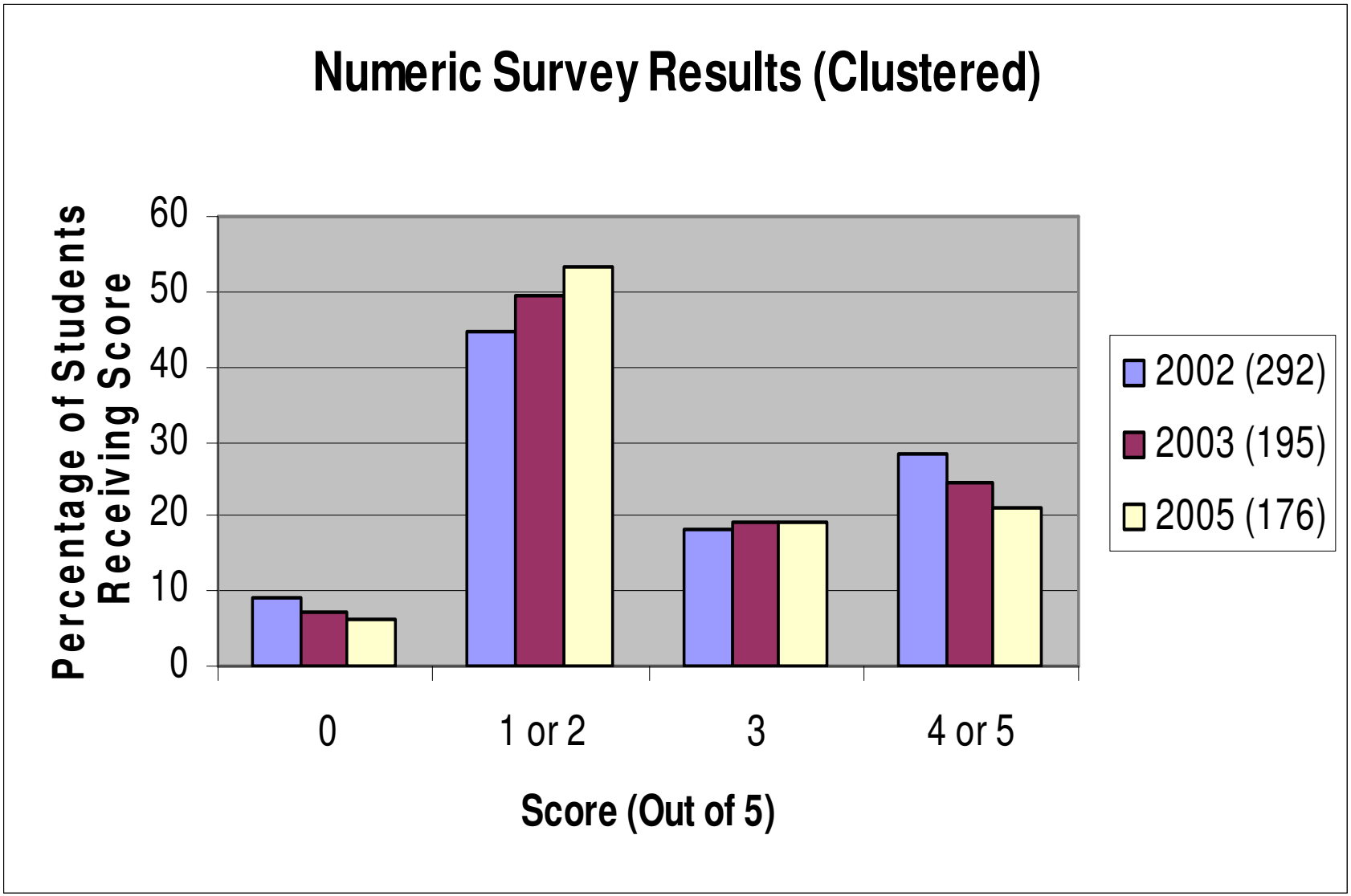

Letter Code Scheme
Percentage of Students
35
30
25
20
15
10
5
0
P
B
G
R
M
S
I
V
D
T
Letter Code
2002 (292)
2003 (195)
2005 (176)


Indicators of Good vs. Poor Understanding of Student Participants
Percentage of Students [%]
70
60
50
40
30
20
10
0
2002 (292)
2003 (195)
2005 (176)
Indicator of Good Understanding
Indicator of Poor Understanding

Interesting Results

- From 2002 to 2005, student responses containing indicators of good understanding dropped from 56.2% to 48.9%

- From 2002 to 2005, student responses containing indicators of poor understanding increased from 14.7% to 29.0%


Numeric Survey Results (Clustered)
Percentage of Students Receiving Score
60
50
40
30
20
10
0
0
1 or 2
3
4 or 5
Score (Out of 5)
2002 (292)
2003 (195)
2005 (176)

Interesting Results

- Student scores in the “4 or 5” category decreased by 7.4% from 2002 to 2005
- Student scores in the “1 or 2” category increased by 8.9% from 2002 to 2005
- Scores in the “3” category stayed roughly the same
- Scores in the “0” category decreased by 2.7%

Why is the transition getting harder?

- Mathematical maturity of students (procedural vs. conceptual learning)
- Summer losses
- Confidence and care in answers
- Different education
- University courses need more adjustment

Can we make the transition smoother?

- Math Background surveys as diagnostic tools; adjust courses
- Collaboration between High School and University teachers
- Changes in curriculum (both in High School and University)

Thank you

Future Work

"The importance of communication in mathematics is a highlight of the secondary school curriculum. In all courses, expectations are included that require of students the clear and concise communication of reasoning or of findings"

- We would like to incorporate an indicator for communication in our study

Letter Coding Scheme

- P – uses the shape of the curve to explain their answer. If stated properly, this could be adequate (i.e., the velocity is increasing because the curve is concave up) or not (eg, the curve goes up and to the right)
- M – involves the (inadequate) statement that more distance is covered in less time.
- R – involves the adequate statement that more distance is being covered over set (equal) time intervals
- G – uses the assumption that the graph is a specific curve such as a parabola, exponential or power curve. (not completely adequate, but on the right track)
- B – mentions that the slope/curve/graph/slope of curve/slope of graph is increasing. If they mention the slope of the tangent is increasing, they get full credit.
- S – says the slope is positive (inadequate)

Letter Coding Scheme Cont'd

- D – uses or mentions derivatives in some way; basically, understands the idea that a derivative is involved
- I – says the velocity is increasing because as time increases, position/distance/displacement increases.
- V – says the velocity is increasing because the velocity/speed is increasing (this response was surprisingly not rare)
- T – mentions the term 'tangent' somewhere in their response

Indicators:

- Indicators of good understanding: D, T, B, R, G
- Indicators of poor understanding: I, V, M

Numerical Coding Scheme

0 – incorrect answer (decreasing). If it was accompanied by an explanation, the explanation received a letter code.

1 – correct answer (increasing) without an accompanying explanation

2 – correct answer with some attempt at an explanation. In this case, the explanation is either mathematically incorrect, not relevant (eg. Increasing, since the slope is positive) or nonsensical.

3 – correct answer with accompanying explanation. In this case, the explanation is either on the right track, but not precise enough or partly correct and partly incorrect.

4 – correct answer with accompanying explanation. In this case, nothing about their statement is incorrect, but the response is either not completely precise or there is some ambiguity in the terminology.

5 – correct answer with accompanying explanation. The explanation is precise and at most would have a minor detail missing.