

Unit 2
Independent Study
(10-15 %)

Independent Study

Outcomes

SCO: In Mathematics 2204/2205, students will be expected to

I1 demonstrate an understanding of a mathematical topic through independent research

I2 communicate the results of the independent research

Strategies for Learning and Teaching

I1 and I2

The purpose of this independent study is 1) to prepare students for learning independently, and 2) to provide students with the opportunity to explore

- in more depth, mathematical content that they have been exposed to but would like to know more about
- new mathematical content areas not yet explored
- mathematical topics of interest
- historical studies and connections to the math we study
- mathematics in our lives, and related to careers
- mathematics through the Internet
- how people learn mathematics

Approximately 10–15 hours of class time should be devoted to this research project. Teachers should allow time for

- students to present the results of their research and learnings to other students (presentation time of about 10 minutes per student should be allowed for). If students are working collaboratively on this project, it is expected that each would be responsible for gathering certain information and thus could be held responsible for the oral presentation that deals with that part of the project.
- initial discussion and discovering of ways to get information, what it means to learn mathematics independently, and why that is important (the resources should supply activities to stimulate this)
- an introduction to topics not yet studied to whet students' appetites.
- discussing the expectations and assessment rubrics for the student presentations at the end of the unit and how they will be assessed during the unit.
- brainstorming, topic-webbing, developing action plans and time lines, conferencing

Managing the Project

The managing of the project should be very teacher-directed:

- various topics will determine the appropriate group size
- some students may wish to work independently
- students will choose appropriate topics (perhaps from a teacher-prepared list) that are appropriate and of interest to them. Teachers should ensure the availability of reference resources (material and human) in or around the school, or the community and should give final approval for each topic.

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Independent Study

Tasks for Instruction and/or Assessment

Resources/Notes

- *New Topics for Secondary School Mathematics, Matrices*, NCTM, 1988
- de Lange, Jan, *Meaningful Math, Matrices*, WINGS for Learning, 1992
- de Lange, Jan, *Flying Through Math, Trig, Vectors, and Flying*, WINGS for Learning, 1991
- Froelich, Gary et al., *Discrete Mathematics Through Applications*, W. H. Freeman and Company, New York, 1994
- Jacobs, Harold R., *Mathematics, A Human Endeavor*, Third Edition, W. H. Freeman and Company, New York, 1994
- Serra, Michael, *Discovering Geometry*, Second Edition, Key Curriculum Press, 1997
- Charles, Randall et al., *How to Evaluate Progress in Problem Solving*, NCTM, 1992

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- brainstorming or topic-webbing should take place
- action plans should detail the tasks that have to be completed (it is assumed that each student will have responsibility for independent work within the structure of the project) For example:
 - write letters to gather data or request materials
 - make phone calls for information, read texts, newspapers, flyers, journals, and reports
 - complete library search
 - interview resource people
 - reflect on and share ideas with group members
 - prepare oral presentation
 - prepare written submission
 - complete internet search
- each student or group should detail their own time lines to match the teacher's
 - deadlines should be determined for the work that has to be completed, and for bringing completed work to class. Regular conferences regarding progress are crucial. This includes conferencing with group members and with the teacher.

Suggested Topic and Content Areas

New Content

- vectors with respect to navigation and forces, graph theory (4-colour problem and travelling salesman problem), or other topics found under the heading 'Discrete Mathematics', applications of matrices such as Markov Chains, and Leontief Input—Output models

Topics for More Depth

- proof in mathematics
- algebraic manipulation
- functions, compositions of functions, fractals - connections to art
- regression analysis
- the story on infinity and zero
- parametric equations
- conics from a geometric perspective

Mathematics in our Lives

- Fibonacci numbers—connecting to the world
- geometry in our lives—patterns, design, architecture
- mathematics in jobs—interview a person about how he/she uses math in his/her job
- do statistics lie?
- consumer mathematics
- career options
- leisure mathematics—non-routine, recreational problems, logic, math games, puzzles, games of chance
- the Internet as a source of mathematics information

Independent Study

Tasks for Instruction and/or Assessment

Resources/Notes

Note

Technology tips column in Mathematics Teacher has a web page in every column connecting to interesting Math History topics, applications, etc.

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SCO: In Mathematics 2204/2205, students will be expected to

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I2 communicate the results of the independent research

I3 demonstrate an understanding of the mathematical topics presented by other students

Strategies for Learning and Teaching

I1/I2/I3 Teachers might facilitate this unit by:

- focussing 10–15 hours on the project all at one time—teachers should be aware of the time needed to gather and compile information
- spreading the project over a term, with some class periods being designated to the project introduction, and as checkpoints, each with a particular expectation, and for finalization, preparing and performing presentations
- integrating it with a topic going on at the same time in the classroom—statistics, algebra, indirect measurement.

Expectations for assessment must be made clear to students:

- all students must be involved with the presentation with respect to discussing what mathematics they have researched
 - oral presentation to class, or
 - oral presentation on video and played to the class, or
 - conversation between students or among group members in front of class or on video, or
 - teacher/student interview (private or in front of class) or,
 - some other variation of presentation forum.

Executive summaries must be distributed to the class at the time of presentation. This means that students should summarize the new mathematics learned so that other students can read over the summary, see a couple of examples and have a pretty good feeling for the new topic.

Assessment

- Criteria for written submission should be prepared by the teacher and made clear to the students prior to assigning the project.
- Criteria for presentations should be made clear (students should not simply read their written submission).
- A rubric (students could help design it) should be included that allows for assessment on the written work as well as the presentation.
- Peer evaluation should occur during presentations and from each group member on the group effort and could include a relective journal entry on their experience within their own group, as well as their experience in seeing and hearing from other groups.

continued ...

Independent Study

Tasks for Instruction and/or Assessment

Resources/Notes

- *Assessment Alternatives in Mathematics*, Equals Publishing/Lawrence Hall of Science, University of California, 1989
- *Mathematics Assessment: Myths, Models, Good Questions, and Practical Suggestions*, NCTM, 1992
- Charles, Randall et al., *How to Evaluate Progress in Problem Solving*, NCTM, 1992

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A possible rubric for the written component might look something like the following:

Top Level

- contains a complete report with clear, coherent, unambiguous, and elegant explanations
- includes clear and simple diagrams, charts, graphs, etc.
- communicates effectively to an identified audience
- shows understanding of the mathematical ideas and processes and perhaps original thought
- identifies all the important elements of the topic
- includes examples and counter-examples
- gives strong supporting arguments

Second Level

- contains good solid report with some of the characteristics above
- explains less elegantly, less completely than desired
- does not go beyond the requirements of the project (or topic)

Third Level

- contains a complete report but the explanation is muddled in places
- presents arguments but is incomplete at times
- includes diagrams but some are inappropriate or unclear or misplaced
- indicates some understanding of mathematical ideas, but not expressed clearly enough

Fourth Level

- omits significant parts
- has major errors
- uses inappropriate strategies

See the books in the Suggested Resources column for more examples of rubrics for evaluating projects and open-ended activities.

I3 Students should collect executive summaries from students who are currently presenting. Students should ask questions for clarification at the end of presentations. Students might demonstrate their learnings from presentations of others by completing a questionnaire that focusses on the highlights of a presentation. On a test, teachers might ask students to discuss, showing examples, what was learned from any presentation. Another strategy for assessment might be through a conversation between the teacher and student about someone else's project. Since students are expected to read the executive summaries of other students, teachers can consider requiring a journal entry on their learning from each of the other projects.

Independent Study

Tasks for Instruction and/or Assessment	Resources/Notes

