



Section 1

Math And The GED 2002

Introduction

As the instructor in *GED as Project*, you will be using the math-focused Learning Projects and accompanying Inquiry Activities presented in this guide, along with ones you develop to help your students pass the math portion of the GED 2002. The Inquiry Activities presented here use Official GED Math Practice Test questions as stimuli and can serve as models for the ones you will design. All Inquiry Activities employ discovery and group learning, encouraging the development of analytical, creative, and practical thinking as well as test-taking skills for the GED 2002. By developing GED math instruction in this way, you will begin to incorporate and develop thinking and problem-solving skills along with content knowledge.

The Learning Projects and Inquiry Activities used throughout this guide employ an integrated approach to learning. Because GED 2002 math requires reading comprehension, thinking, reasoning, estimation, and, finally, computation skills, we incorporate these reading, writing and thinking skills into our instruction. By asking learners to think differently and at a higher level, *GED as Project* becomes an excellent vehicle for transforming math instruction. As a result, your responsibilities adjust and change from heavy reliance on direct instruction to a greater balance between

guidance and instruction. In this approach, learners will struggle with understanding math, reading and reasoning within the Learning Projects they and other classmates undertake. From this effort comes deeper learning and greater understanding for the learner.

Through the questioning in the Inquiry Activities by the instructor and with each other, learners will discover the need for reading within the context of math. They will discover that reading is contextual, that they must learn to read math word problems in order to be successful. As the instructor, you will guide learners to process information, facilitating them to think about math, not just to recall facts. You may develop Learning Projects and corresponding Inquiry Activities yourself and ask questions so that learners come to understand the math concept connections among different kinds of problems. Ultimately, you will lead the learners toward developing and solving their own Inquiry Activities for the Learning Projects they have identified. You will guide the learners to the underlying concepts, connections, thinking and reasoning of the GED test questions, not merely the computational skills necessary.

Introduction to Math Learning Projects

An important component of *GED as Project* is that the problems on the Official GED Practice Test are used as stimuli in the Inquiry Activities for rich instruction that engages students in reading comprehension, reasoning, and analytical, creative and practical thinking. The sequence in which the GED practice test items are examined should provide a coherent course of study that builds on similar ideas to construct more complex, abstract concepts. The groupings of GED Practice Test items that build on similar ideas are collected together in Learning Projects. The test questions grouped into a Learning Project and sequenced into Inquiry Activities build upon each other in an effort to make clear the math concept serving as the foundation of the Learning Project.

The sequence of GED practice test items in Learning Projects — from simple to more complex — connects, integrates and advances previously learned math concepts. You will find that you are not using the traditional adding, subtracting, whole numbers, fraction and decimal skill sequence of traditional math instruction. In the active learning process, the learner is asked to recognize the underlying tapestry of coherence when he/she connects, integrates and advances pre-



viously learned math concepts designed into the Learning Projects. Even learners with higher computational skill levels can benefit from the Learning Projects and Inquiry Activities, focused as many of them can be on math reading and reasoning.

Using an Official GED Math Practice Test, this guide has provided an example of test questions collected into Learning Projects that build reasoning power. (We are using the Practice Test PA from the 2002 GED test.) Ultimately, you may want to group, as well as sequence, the test items into your own Learning Projects and accompanying Inquiry Activities to ensure that learners in your classroom will be exposed to the fundamentals of math, progressing from easy items to the more difficult ones.

To help you with collecting and sequencing test items into Learning Projects and Inquiry Activities, we have provided “What Math/Test-taking Skills Can You Access?” (Appendix 1.) This document lists each Math Practice Test question in the left-hand column, and enumerates the Accessible Math Content, Learning Skills and Test-taking Skills in three columns. This allows the instructor to gather together test questions that have similar accessible math content, learning skills, or test-taking skills.

Once similar test items are grouped into a Learning Project, then the test items in that Learning Project are sequenced into Inquiry Activities. The instructor can sequence the test items to expose progressively the math concept and/or learning skills that are the subject of the Learning Project. The sequence of Inquiry Activities within the Learning Project can be done in any way the instructor wishes, depending on the class members, the math the instructor wishes to emphasize, or any math goal the instructor and the class want to pursue.

Introduction to Math Inquiry Activities

As a final element of the process of Learning Project and Inquiry Activity development, a template for the Math Inquiry Activities is also included. The Inquiry Activity Template is presented as a series of steps and questions that fulfill the learner-centered thinking and process proposed by this guide.

The template (Figure A) has five major headings. The first three headings (Identify the Problem, Become Familiar with the Problem and Planning, Assigning and Performing) are important to the student, both as a learner and as a math test-taker. The approach to a test item outlined in these steps provides the test-taker with a standard procedure that can ease

the tension of a test-taking situation. The final two items in the template – Sharing and Reflecting, Extending and Evaluating – are for the student as a math learner, focusing on the construction of meaning beyond the specific item itself. This emphasis is in keeping with the goal of this guide – that is, to build on the motivation of the student who wants to pass the GED but also to present a more complete picture of GED mathematics.

A more detailed discussion of this template follows.

Figure A

Template for Math Inquiry Activities – for the Test-Taker and Learner

- 1. Identifying the Problem**
- 2. Becoming Familiar with the Problem**
- 3. Planning, Assigning and Performing Tasks**
 - *Doing the Work*
 - *Express the Problem in Other Terms**
 - *Estimate Before Computing**
- Reaching a Conclusion**
 - *Come up with an Answer*
 - *Compare Answer to Estimate**
- 4. Sharing with Others**
- 5. Reflecting, Extending and Evaluating**
 - *Think about what you learned*
 - *Extend what you learned to new situations*
 - *Assess what you learned and how you learned it*

** Optional, depending on test item*

Introduction to Math Inquiry Process Template

The Math Inquiry Template provides a guide for thinking through the Inquiry Activities within the Learning Projects. You will note that the template designed for mathematics inquiry and extension activities is a modification of the overall template that is described for use in “The GED and You” Learning Project in Volume 1. Specific additional steps that apply to mathematical topics have been inserted, suggesting explicit methods that can develop math comprehension skills through analytic, creative and practical thinking. The num-



bered steps in the template (Figure A) are intended for all Inquiry Activities. The bulleted subsections of step 3 (Planning, Assigning and Performing Tasks) are designed to develop test-taking skills for the participant. Test items that do not involve computation will not require the steps that involve estimation.

Use creativity as you group the math concepts in test questions into Learning Projects and as you design the Inquiry Activities within those Learning Projects. Focus on the learners' progress toward their goals to pass the GED and allow their unique learning profiles to introduce variety into your design. The grouping of test items into Learning Projects, the focus of the Learning Project, and the sequencing of test items into Inquiry Activities can all vary depending on the makeup of the class. The actual classroom proceedings are likely to vary even more than you intend as each different group brings a different attitude each day.

Be flexible enough to make on-the-spot decisions as to the most appropriate way to modify the Inquiry Activities so that they meet the apparent needs of the group that day. Your modification may include:

- Extending the GED test question stimulus by adding new parts or changing some of the facts or numbers that would engage learners in further exploring the mathematical concepts imbedded in the original stimulus;
- Changing the stimulus questions (asking “what if?”) by adding different variables within the same Inquiry Activity to allow more complete understanding of a particular concept;
- Making connections between math concepts within Learning Projects required by one Inquiry Activity to those required by others. Learners should be prompted to uncover the connections themselves, but may need help, perhaps from a Burst Lecture or a concept map, when they are unfamiliar with this kind of thinking.

Math Inquiry Process Template

A detailed discussion of the Math Inquiry Activity Template follows.

1. Identifying the Problem

Step 1 of the template is an important first step in the test taking sequence. At this stage of the process, learners should read the item carefully, decide just what the question is asking and then determine what kind of response is required: e.g., miles, hours, rate, number of items, cost, etc. The participants should not, at this point, go beyond getting an understanding of the words used in the problem and the kind of response required. This narrow focus for Step 1 is recommended because the template is setting up a process for the test-taker that can be used under the conditions of the actual test.

Some suggestions may encourage the participants at this step (and keep them within the test-taking process suggested).

- *Read the question carefully, as you would if taking the actual test.*
- *Here are some problem clarification questions you may want to consider when reading test questions:*
What words and/or symbols might be important to understand in order to answer this problem and what are they telling you?
What words and/or symbols are unfamiliar and what do you think they mean?

2. Becoming Familiar with the Problem

In Step 2 of the test taking sequence, the learner is engaged in the situation, or context, of the problem. To simulate test-taking conditions, this should be an individual activity. The step is introduced by the following to keep the learner focused on the test-taking process:

Ask yourself questions (like the ones on page 4 for example) about the problem, taking note of the ones that were especially helpful so that you can remember to use them when you take the test.

Here are some familiarization techniques that you as the facilitator could choose to use. The demands of the test item itself will determine which of them is appropriate. Develop others keeping in mind that what you ask the



learner to do here should be able to be done under test conditions.

- Reread the question. What is it asking you to do?
- What do you already know about this kind of problem or about the math required?
- Focus on the action that is described in the item. Is it separating things or bringing things together? Is it asking for a comparison? Does it compare in a simple way, e.g. more than or less than, or does it ask how many times greater or less? This kind of thinking can be used as a step to discussing, later, which operation will carry out the action.
- How does reading comprehension help you to familiarize yourself with the problem? Can you restate the question in an easier way?
- How is reading a part of this problem? What do you have to do to be able to read the problem in order to become familiar with it? Are there any words or phrases that you don't understand? (Non-native speakers often do not catch the meaning of some Americanisms.)

Choose the familiarization technique most appropriate to the situation and the level of the learners. The idea here is to get the learners to ask these kinds of questions constantly so that when they are taking the test, they have a process to fall back on. Concentrate on the problem itself. There will be an opportunity to go beyond the specific problem in the later steps of the Inquiry Activity.

3. Planning, Assigning, and Performing Tasks

Planning

This is the step in the test-taking process where we ask the learners to come up with an answer. To simulate test-taking conditions, we suggest the following to the learner:

Try to answer the test question any way you can, even if you have to guess, but try to be aware of the reasoning and operations that you are using. The following directions and questions can be helpful.

Assigning

This would generally be an individual activity so there would be no assigning of tasks.

Performing Tasks

Doing the Work

In this stage, the test-taker's aim would be to find the answer to the item, but the learner should be asked to go through the steps as outlined here so that the skills developed can be used under test conditions. A whole series of questions and directions can be used at this point, depending on the problem. One such direction would be:

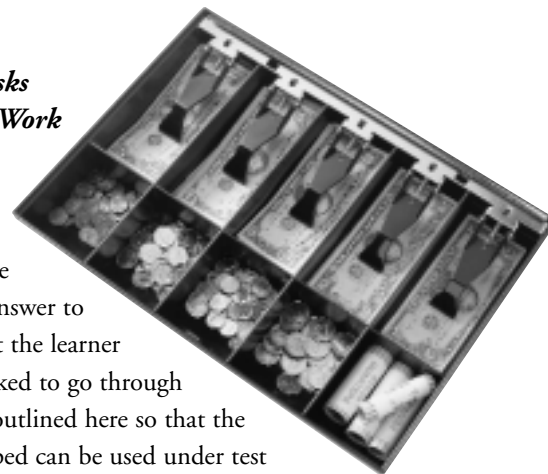
- ***Express the Problem in other Terms***

One way the learners can start thinking about math is to ask them to mathematize the situation. This can be accomplished by writing a mathematical version of the situation and the action described using symbols, numbers, operation signs or relationship signs. Some GED items, known as set-up items, give answer choices that are in the format of mathematical equations or expressions. If this is the case, the test-taker is finished at this point. Otherwise, the test-taker would follow the next steps in determining how best to find the answer. In either case, the learner is just getting started because in Step 5 you will use the opportunity to tease all the math out of the item.

- ***Estimate the Answer before Computing***

Estimating is one of the most crucial steps in the math process for both test-taker and learner. Many cognitive and context skills are involved.

An examination of the GED Math test shows that many of the multiple choice questions can be answered with good estimation skills alone. A test-taker can estimate an answer, review the answers in the test questions and discard the ones that obviously do not come close to the estimation. He/she does not always have to complete the calculation, just know how to estimate well. Learners, on the other hand, should not stop at the estimating phase of the Inquiry Activity. A goal is to have the learner get a good estimation and become aware what he/she was thinking and doing when estimating.



Here are some of the ways a learner can become aware of the process of estimation:

- Make an estimate.
- Note the steps used to arrive at the estimation. The learner should articulate as much of that process as possible. Creative and practical methods will surface at this point, reflecting a variety of ways to think about numbers, each potentially valid in its own right, with which the individuals feel most comfortable.
- The learner can answer the question: How does reading and understanding the problem and knowing the terms used in the problem help in the estimation process?

Reaching a Conclusion

The next two exercises continue the process for the test-taker.

• Come Up with an Answer

At this point the learner must come up with an answer to the question.

• Compare Your Answer to the Estimate

Comparing answers to estimates is an activity that reinforces the estimation step but also includes thinking and math comprehension skills.

This step can lead to discussions on how to estimate, how estimation can be used to answer multiple choice questions and what thinking skills are needed to do good estimation. When you think these kinds of questions are appropriate, you can ask the learners to answer them in Step 4, Sharing With Others.

Some other points that can be addressed at this stage are listed below.

- Insist that the answer is only part of the learning process. The learners should be able to explain to others all of the thinking and the computational work that went into the problem solution.
- Determine the best method to do the problem in light of taking the GED test.
- Have the learners write out answers to problems in sentence form for some Inquiry Activities. This helps with the math thinking process, gets the learner back into the words of problem and reinforces the reading and estimation phases of the process.

4. Sharing with Others

This is an activity that every GED content area will have. Communicating their understanding reinforces the learners' making meaning of the problem they have completed. Having groups share their activities puts them in the role of teaching others. One learns best when one teaches.

The groups discuss and then report to the class the ways they solved the problem, how their estimates compared to the answers they got, examples of how the problem may appear in daily life and any other questions covered during Steps 1 through 3. The groups should be encouraged to lead class discussions, further helping to build communication skills.

5. Reflecting, Extending, and Evaluating

Step 5 in the template is devoted to the learner whose aim is broader than the test-taker. The learner is encouraged to learn about the mathematics represented by the item. An important reason for not stopping at the test-taker process through Step 3 is that the problems on the GED might be significantly different from the Practice Test problem. The learner has to explore other ramifications of the problem to be able to handle such items on the GED test. Step 5 gives the learners that chance.

Reflecting: Think about what you learned.

Each reflecting step is introduced with the following comment to reinforce this very important thinking skill:

Here are some questions to start you thinking about the experience you just had. Thinking about what you have learned and experienced is part of the learning process. When the focus is only on the answer, you don't get much time to think about what was learned.

Reflecting questions tend to be analytical in Sternberg's *Successful Intelligence* model (Robert Sternberg, *Teaching for Successful Intelligence*, 2000). There are numerous issues you can ask the participants to reflect on. They can reflect on:

- Thinking skills learned
- Reading comprehension strategies used
- Math concepts mastered
- Math concepts to be mastered
- Test-taking skills developed.

Other reflecting questions that could also be asked follow.

- What did I need to know to be successful in getting this answer?



- Is there a different way to learn about the concepts presented here?
- How will this Inquiry Activity help me pass the math portion of the GED?

Extending: Extend what you learned to new situations.

Each extending step is introduced with the following comment to reinforce this very important learning skill:

In extending, you are being asked to transfer the information presented in the Practice Test question to other information or situations you already know and maybe to make new connections to other information.

The learner now gets a chance to build on the knowledge gained by making connections. Understanding relationships, observing patterns and recognizing differences are all important in getting a deep understanding of math concepts. These skills also help learners to think like a mathematician, a kind of thinking that may be more valuable to a GED test-taker than computational dexterity.

All of these extending activities can be done in groups and reported to the rest of the class. These questions tend to be creative and practical in Sternberg's *Successful Intelligence* model (2000.)

• Connections to Math Learned in Other Inquiry Activities Within Learning Project

Performing this step allows learners not only to understand math as a series of related concepts, but it also develops the fuller context of math, a context in which the imbedded reading and thinking skills are more apparent.

The connection to other math learned is divided into two parts. Part 1 is the connection to the math in the other Inquiry Activities that make up the Learning Project. As previously stated, the Learning Projects are chosen by instructors to contain Inquiry Activities focusing on a math concept in different math contexts and levels of difficulty, so that there should be a connection among all the Inquiry Activities within the same Learning Project. This connection is to be explicitly made here.

There are many techniques that can be used to encourage the connection to other math learned in related Inquiry Activities within a Learning Project. You can ask direct questions about how the math learned is the same and/or different in each of the Inquiry Activities. Another approach that can be effective is asking them to use their creative abilities by acting out the connections.

• Connections to Math Learned in other Learning Projects

The second part of making connections involves understanding relationships between Learning Projects, where there may or may not be an intended connection. This can also be an exercise where the creative abilities of the learners are encouraged. The Learning Projects may relate to one another only when looking at the big picture, so finding connections and articulating differences helps reinforce the understanding of the concepts involved.



You can use the same techniques to make connections between Inquiry Activities. It would be helpful to have a concept map to show connections among the Learning Projects and or Inquiry Activities used in the Math Section of *GED as Project*.

• Discover Different Ways to Solve the Problem

Here the learners can really get a chance to tap into their analytical, creative and practical intelligence. First, to get to an answer, they might have used a traditional procedure and/or computation skills. But now, getting a second way to come up with an answer encourages them to go outside the correct, or most mathematically efficient, or the by-the-book approach to doing a problem.

The context, the learner's experience and the learner's creative and practical intelligence come into full play. We are not asking them to think in a confining or rote way about math. We are, in fact, encouraging them to think outside the academic math box.

This can be done in groups. Each member of the group should be prepared to explain to the other members the different ways that he/she used to answer the question. The group can report all the various problem-solving methods to the whole class.

Here are some thoughts on activities that can be used at this point:

- Initially, the instructor's role is not to direct learners to the right answer or the right method, but to let them be as expansive in their thinking as possible. The instructor then uses the learners' ideas as a Just-in-Time assessment, and finally, guides the group or the class to the math method that is most efficient and effective in order to answer the stimulus

question in the GED's timed-test environment, being careful to note that other methods may be better in other situations.

- One possibility that should be explored regularly is how the calculator could have been helpful in understanding and/or solving the specific problem.
- At this point the facilitator can introduce similar problems so that the learners have a chance to transfer and practice their skills.
- The group can agree on the most efficient mathematical way to do the problem, find in the texts explanations of how to do the problem and have the class discuss their research. Then they could research the other ways to do the problem.
- The class may also start keeping a list of terms or situations in problems that require certain math operations to be performed. This list may be maintained in poster form in the classroom and/or kept individually by students.
- The learners should discuss the similarities among the methods, what new approaches anyone learned, or the text support for the computation. During this time the facilitator does a Just-in-Time assessment and can make extensions or adjustments to the item, connections that could be made with other problems, and whether homework on computation would be in order for some or all of the learners. You will notice that the work of the groups does not stop at the right answer.
- The learners could revisit the stimulus and change some of the numbers or situation facts and determine how that changes the answers or the estimation process.
- Groups of learners can develop questions that are similar to the stimulus question and have other groups solve the problems.



• Match the Problem to Your Experience – Find Examples in Daily Life

Again, this is chance for learners to engage their creative and practical intelligence and a way for them to make concrete some abstract math concepts. This is not a step that helps learners with the GED itself, but it does develop their broader understanding of math as a tool to think about and solve everyday problems. Developing that understanding goes a long way to understanding the concepts that underlie math.

The more examples that the learners can match to daily living, the more aware each learner becomes about math. There are wonderful opportunities for the learners to share their examples and the math connections they made to those examples.

Evaluating: Assess what you learned and how you learned it.

Each evaluating step is introduced with the following comment to reinforce this highest thinking level in Bloom's Cognitive Taxonomy:

In this last step, you get a chance to review the content of what you learned and the methods used to learn.

There are no right or wrong answers to these questions; it is your chance to look more closely at your learning style and the opportunity to state how you benefited or didn't benefit from the content and/or the methods to help you pass the GED test.

The evaluation process is similar to the reflection process, but it tends to be more personal to each learner. Here are some evaluation questions that could be asked. These questions tend to be analytical in Sternberg's *Successful Intelligence* model (2000).

- What strengths of mine were apparent during the Inquiry Activity?
- What weaknesses were exposed, and what can I do to correct or compensate for them?
- How can I correct a perceived weakness?
 - Do I need to commit to attending class more regularly, schedule more time to complete homework and/or complete my homework?

As you can see, the Inquiry Activity template is dynamic and can be applied to different situations in multiple ways.

Student versions of all of the Inquiry Activities that follow may be downloaded from the *GED as Project* web site: <http://www.jmu.edu/gedproject>.