Concepts and Processes Sequences: An Informal Student Guide

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This guide is designed to help you adjust to and succeed in Math 130 or Math 140, courses which will likely be different from your previous mathematics courses. Although written by one instructor, this guide applies to all sections of the course. Your instructor will provide you with additional information on policies and procedures specific to his or her section of the course. The guide is divided into four sections: *Introduction*, *In Class*, *Assessment*, and *Support*. Please keep this guide for reference.

I. Introduction

Some Background:

The *Concepts and Processes Sequences*, Math 130/131/132 and Math 140/141, are mathematics courses designed primarily for future teachers of grades pre-K to 6. For many years in the U.S., including the years that your elementary school teachers were in college, it was often accepted wisdom that elementary school teachers learned all the mathematics they needed for teaching before college. Elementary school teachers could teach children how to do "plus, minus, times, and divide," step-by-step, without necessarily knowing where the steps came from or why they worked. Entering college, many future elementary and early childhood teachers felt that mathematics was their weakest and least favorite subject.

What's Changing Now?

As you are well aware, technology has made major changes in both the classroom and the workplace. The traditional K-5 mathematics curriculum spent six years teaching kids how to do what a $3 calculator from CVS can do more accurately. Before calculators, learning to compute by rote was an incredibly useful skill, and while computation skills are still very important, it hardly makes sense to focus on them almost exclusively, when in the real world, pretty much nobody tries to find $13,766 \div 243$ without a calculator. These days, it's usually more important to be able to estimate, to evaluate whether an answer seems reasonable, and to understand the meaning of a mathematical statement, than to do things like divide big numbers with pencil and paper.

Also, for many years in the U.S., mathematics education has often been used to separate students: those who understand are labeled "good at math," and those who don't are labeled "bad at math." Compare the situation in math and in reading: teachers, parents, and the general public assume that virtually all children can learn to read, and if a child isn't learning, the adults work to figure out how to teach that child. In math, on the other hand, parents and teachers often assume that many people just aren't good at math, so when a child struggles, it's easy for them to conclude that that child will never learn. Of course, when a teacher is not comfortable with mathematics, it's much more difficult for that teacher to modify his or her teaching methods to reach ALL children.

For many students math education has been about learning to sit still and follow instructions, whether the instructions make sense or not. This kind of education is a way of training people to be obedient workers. Since 1989, however, there has been a national reform effort to change mathematics education; one aspect of this effort is using mathematics courses to help students learn to work cooperatively to solve problems, a skill that is important for many jobs (and other parts of life). Although you were probably born around when the reform effort began, your previous math classes might or might not have been influenced by it, depending on where you went to school (if you used the IMP curriculum in high school, you have definitely felt the influence of this movement; to some extent the MCAS exam in Massachusetts also reflects the reform movement).

One good place to find out more information about math education is from the National Council of Teachers of Mathematics. You might want to check out their web site at www.nctm.org or their journals in the library (*Teaching Math to Children, Mathematics Teaching in the Middle School,* and *The Mathematics Teacher*).

What About Me?

I often speak at first year orientation and ask students to raise their hands if they like math; the results have been fairly consistent in the last few years. In a typical session with thirty students, about four people raise their hands, and later, when I ask how many students hate math, at least half the hands go up. So, most probably, a few of you like math, and presumably have had positive experiences in your own math classes, and many more of you are entering the *Concepts and Processes* Sequences with the typical backgrounds and attitudes described above.

So, first, let me say, "Welcome," whether your previous experiences with mathematics have been tremendously wonderful, utterly awful, or anywhere in between. For those of you who've had great experiences with mathematics, I'm sure you want others, especially children, to have them too. For those of you who've found your mathematics classes incomprehensible, boring, humiliating, or irrelevant, I'm sure you want to do better in your own teaching.

What mathematics do I need to know to teach mathematics well?

First, you need to have a good relationship with mathematics yourself. You need to be able to solve unfamiliar problems and explain their solutions, to understand mathematical concepts, to listen to and make sense of other people's thinking, to represent mathematical ideas in many different ways, to make connections between various areas of mathematics, and to justify your thinking. You need to be a competent mathematical adult in the world – able to understand the mathematics of important social issues, to use mathematics to make financial, medical, and other decisions, and to generally be a "quantitatively literate" person.

Second, you need specialized mathematical knowledge for teaching. You need the mathematical background that will enable you to deeply understand the content you will teach, pick out the important mathematical ideas in a lesson, modify lessons to address the range of learners that you teach, decide which ideas to pursue in a classroom,

choose supplementary material, understand how concepts fit into a curriculum well beyond the age group you are actually teaching, and discuss your work with parents and principals.

You will need to know about how children think about mathematics, what topics are developmentally appropriate for what children, how gender, race, class and other factors affect mathematics education, how to address students with special needs, how to manage a classroom, and many other important topics. We won't be studying these topics directly in *Concepts and Processes*; you'll study them in depth in your education courses.

That sounds like a lot…

It is. Teaching is an incredibly important profession, and doing it well is difficult. Mathematics has not traditionally been taught well to most children. You are part of an important transition, part of changing the way mathematics is taught, part of making mathematics accessible for many more people. We expect a lot out of you in this course, and we also expect a lot of ourselves as instructors.

But what if I only want to teach first grade? Do I really need to know all that math?

Yes, you do. Many children struggle when they get to topics such as fractions, negative numbers, and algebra because they aren't able to connect these new topics to their previous understanding of mathematics. Teachers of young children need to understand concepts throughout the K-12 curriculum, so they can teach in a way that gives children a foundation for later understanding. Additionally, even if you are working with very young children, you will still need to address a wide scope of understanding, and you will need to supplement for advanced learners.

As a teacher of young children you will probably teach many subjects, so no matter which subject is your least favorite, some of the children you teach will love that subject, and you need to be prepared to nurture that love. This past summer my cousin's son, who had just finished first grade, excitedly told me about a pattern he had noticed concerning multiplication by ten. We discussed extending the pattern to multiplication by 100 and 1000, and then to division, including division that gives a decimal as an answer. I certainly hope his first grade teacher knew a lot more math than just the typical first grade curriculum!

The younger the child, the more the teacher has to work to find the mathematics in the child's thinking, and the more mathematics you know, the more you can do that. A few years ago, I was amazed to discover that a first-grader I was working with at a school was thinking about an idea that is very important in calculus. I'm not saying that you need to know calculus to teach first grade, but knowing calculus impacted the way I discussed that idea with that child.

If you are concentrating in Early Childhood Education, right now you are only required to take the first two semesters of the *Concepts and Processes Sequence*; however, the mathematics faculty disagrees with this decision. In the report, *The Mathematical Education of Teachers*, a national group recommends that K-4 teachers

take three mathematics content courses to prepare; they recommend that teachers in grades 5-8 take seven courses.

Now I'm getting kind of nervous. Will I be able to succeed in this class?

It's normal for everyone, including the instructor, to be nervous at the beginning of the semester. Math 130 and Math 140 are challenging courses – we will be asking a lot of you; however, we also want you to succeed, whether or not you have succeeded in mathematics in the past. We want you to be a good teacher. You will have to work hard in the class, and we will push you. We push you out of respect for your genuine potential as a student and teacher of mathematics, even if you don't yet see that potential. The class can be frustrating, but frustration is a normal part of the learning process. Think about when you learned to read or to tie your shoes or to ride a bike -- I'm sure you were frustrated sometimes, but in the end that frustration led to a good thing.

We want everyone in the class to do well, including you. We are not trying to separate out who is "smart" and who is "dumb" or to rank people. We work to make our classes safe places, where people can make mistakes without being laughed at, where people are not afraid to ask questions or to share ideas that are not completely perfect.

However, in order to succeed, you must work hard. The syllabus recommends that you do approximately **eight** hours of homework per week, which is a standard amount for a college course (two or three hours of out-of-class work for each credit). It's important that you take responsibility for your own learning. We will help, but we cannot learn the material for you. In class, we will discuss strategies for challenging yourself to both solve new problems and assess your understanding. We encourage and expect you to go beyond the minimum in your work for this course.

II. In Class

What *Concepts and Processes* is not:

In the U.S. (and many other places) there is often a standard structure for a math class: the teacher reviews homework, then shows students how to do a new topic, the students practice the new topic, then the teacher tells them whether their work is correct or not. If you went to school in the U.S., the chances are pretty high that most, if not all, of your math classes followed this format (when I asked at summer registration a few years ago, every hand in the room went up saying this was the format they were used to for math classes). There are some serious problems with this format, however:

1) Students often don't learn the material. The format encourages memorization without understanding. After the test, the material is forgotten.

2) The students only learn how to do problems that are very similar to the ones the teacher has showed them how to do. They don't learn how to think through new problems or problems that appear in a new context.

3) It gives an incorrect impression of mathematics. Many students learn to think of math as a bunch of disconnected facts that they have to remember for no apparent reason.

4) Students rely on the teacher to tell them whether they are right or not, instead of developing confidence in their own reasoning skills.

5) It leads to very boring classes.

Although there are a lot of problems with the format I describe, it might be the format with which you are most familiar. Even students who don't like this kind of math class still often think that it is the way math classes are "supposed to be." You might find this format boring, but you understand the rules, and that familiarity can be comforting. In *Concepts and Processes* it can seem like all the rules have changed, and that can be upsetting, whether or not you liked the old rules. One purpose of this document is to help you understand what are the new "rules."

What do we do in class?

We don't always do the same things in class, but most classes will be active classes. You will have to work and think in class; you won't be able to just zone out while the instructor goes on and on. You will work with other people. Often you will use manipulatives, which is the fancy education word for toys that help people understand math concepts. Many activities will include visual and/or kinesthetic (involving motion) components.

Class often runs like this: Your instructor will give the class a problem or set of problems. The problem will usually be new, but often related to problems the class has already done. Your instructor will also give an explanation of why you are doing the problem, how it fits in with the goals for the course and what the class has been working on. The class will often discuss the problem together to make sure everyone understands what it is asking. Sometimes you will do some writing or thinking individually and then break into groups; sometimes you will break into groups right away.

Your instructor will circulate between the groups, often just observing what is going on. If you stop your instructor to ask a question, he or she will usually ask you to explain what you've done so far, why you've done it, and how you know it is correct or what you think the problem is. At first, you might find it very difficult to answer these questions, but your instructor will encourage you to try and to practice mathematical communication, which is one of our goals in the class. If you ask your instructor whether you are right or wrong, s/he often won't tell you, but will encourage you and your group to reason yourself. At various points in the class, depending on what is going on in the groups, your instructor might bring the whole class together, ask two groups to consult with each other, ask groups to report on their work, etc. At the end of class, everyone will come together to summarize what they learned, and your instructor will help bring the discussion to a good stopping point. Sometimes activities will take more than one class period.

In many classes a student or small group of students will lead a class discussion that will often begin by presenting student work. In some classes you will look at children's work or videos of children talking about mathematics; you will use these examples to focus on *mathematical* content. The class will spend a lot of time working toward a deep understanding of elementary mathematics – you will find that elementary

mathematics is often not all that “elementary” (some of the things we will study are things I didn’t know, even after I had a Ph.D. in math!).

Other classes will have different formats. Sometimes there will be whole class discussions, sometimes there will be tests, sometimes you will work on the computer, etc.

Does this sound like teaching?

Some students believe that the teacher is only "teaching" when he or she is standing at the board showing them what to do. Sometimes *Concepts and Processes* think the instructors are not doing our jobs when we don't show them how to do something or tell them whether they are right. Often students who have done well in previous mathematics courses have the most trouble with the new format.

You might find this surprising, but the way we teach is actually harder than the "traditional" way of teaching math. When I teach I have to listen carefully to students' ideas and respond to each one in the moment. I have to monitor what is going on in the whole class and make decisions about where to go.

Now don't get me wrong, I am not complaining. It is much more fun and much more rewarding to teach this way. I have taught by lecturing, and in general, I find that it is much less interesting and much less effective than the "hands-on, minds-on" way of teaching. I’ve had times where I was pretty impressed with the way I carefully prepared and then explained an idea, only to find out that afterwards students couldn’t answer the most basic questions about the concept. In order to help you absorb a new idea, I need to know what you already know about the idea, and you need to work to make sense of it – I can’t do that work for you by giving a good lecture. When I do give a short lecture in *Concepts and Processes*, it’s usually for something like to help connect topics or to introduce an assignment. The lectures never take too long, and are never the main teaching strategy.

This course is a *mathematics* course, not a course about how to teach mathematics; however, your instructor will try to model for you some of the teaching methods that you will learn about when you take education courses.

What if I don’t know how to do the problems you give me?

You might think that if you don’t "see" how to do a problem right away, then you don’t know how to do it, and need someone to show you. Furthermore, you might think that people who are “good at math” can just look at any problem and do it instantly. These beliefs are often fostered in math classes where correct answers are the only things that are valued and where speed is emphasized. It is a myth, however, that people who do well in math know how to solve all problems quickly because of some kind of natural mathematical intelligence; people who do well in math do not know how to solve all problems quickly. People who do well in math have the confidence and patience to persevere with an unfamiliar problem and know how to use a variety of strategies to try when they are not sure what to do. In many other countries, there is no concept that some people are naturally good at math; rather, math is seen as something one works at.

Much of the learning in this class will come from sharing your mathematical thinking and listening to that of your classmates. In doing so, you will learn that there are many ways to solve problems and many ways to persist when you aren't sure what to do. You will learn from both correct and incorrect answers. Not all thinking is equally valid, but often confusion and mistakes can lead to discussions that help everyone deepen their understanding of a topic.

III. Assessment

What kind of writing are we going to do in class? Why?

Much of the homework you turn in for the class will be writing assignments, where you will show how you solved a problem, reflect on your understanding of a topic, justify your reasoning, etc. Lots of times in math class students practice artificial skills. Very few tasks in the world look like doing a worksheet of nearly identical problems. By writing you practice your writing skills and you practice learning how to communicate mathematics. These are much more authentic skills. Also, your writing gives your instructor a much better sense of what you understand and what you don't than a multiple choice question ever could. Virtually all mathematics classes that have been influenced by the reform movement in mathematics education include lots of writing.

Why do we have tests? Isn't that a fake skill too?

I have considered not giving tests, but every time I give tests I find that there are some students who surprise me by doing better than I would have expected them to. The course instructors think of tests an opportunity for you to show what you know, as opposed to an opportunity to discover what you don't know. This distinction is very important. One of the key tenets of the reform movement in math is to see assessment as part of learning, not separate from it. In many traditional math classrooms, the whole class stops for a test, to see what people have learned or not, and then they move onto something else. In *Concepts and Processes*, the tests are also an opportunity for you to learn more mathematics.

Also, for better or worse, taking tests is not a fake skill, and you will probably have to take a high stakes test in order to become a teacher, and you probably already had to take such tests to get into college. I am not too happy with the current emphasis on testing, but it's hard to deny that in the world as it is, it's probably good to know something about how to take tests.

What if I don't test well? What if I can't finish in time?

Test anxiety is a problem for some students. If you have a lot of trouble with test taking, you might want to talk to your instructor about making reasonable

accommodations to help improve the environment for you. We never intend for time to be a factor on tests, we are not testing for speed, so if you cannot come early or stay late during a test, you can schedule it at another time when you have more time. To do this, you must talk to your instructor in advance. Some students find they test better if they sit off to the side, facing the wall, so there are fewer distractions. Others arrange a private room in the academic advising office.

Here are some general strategies for dealing with test anxiety:

- Read all the questions first, and start with the one that looks most familiar to you. Once you start working, you will settle down.

- Prepare for the test by doing problems, not by highlighting notes. Redo old homework problems; try to change them slightly. Do the problems from the review sheet and old tests.

- If you find yourself panicking, interrupt your train of thought. Some students start thinking things like, "I'm going to flunk this test, I'm going to flunk this class, I'll flunk out of school, my life is over, etc." Needless to say, this doesn't reduce anxiety. Try to breathe and tell yourself that you've gotten stuck before and solved the problem. No one test is going to make you flunk out of school or even flunk the class.

- If you get stuck, try to write down your thinking and why you are stuck. This might help you get unstuck, but even if it doesn't, in any case, it'll help your instructor see what you were thinking. Sometimes students leave things blank when they were actually close to getting the answer.

- Feel free to move to a different problem and come back later.

IV. Support

What are the study groups for?

Study groups are required. They meet for one and a half hours per week throughout the year and are led by a student math leader (an ML). You have to do homework anyway, and this is an opportunity for you to have a scheduled time where you can work with some classmates and have an ML to help you.

You are encouraged to work with others on homework, however, anything you write-up as an individual must be your own. Unless it is some kind of group project, you should not be with classmates when you write-up an assignment that you are turning in. Don’t do the final write-up during study group! Work on the problem together, then go back and write it up yourself. It is important that you yourself understand what is in your paper, and that your paper is in fact your own work. When you have worked with other people on an assignment, please indicate whom you worked with.

How should I prepare for study group? What do the ML's do?

First, you should prepare for study group. Unless your group meets right after class, take time to prepare before your study group meeting -- reflect on the previous class, make sure you understand the study group assignment, and start thinking about the assignment. It wastes time when students haven't even looked at the problem(s) before study group starts.

Your ML is not going to tell you the answers. The ML's have been trained in the kind of teaching that we use in class -- they are there to help you clarify your own reasoning, to encourage you, to suggest strategies, etc. They are not there to show you how to do the problems or to tell you the answers.

The ML's are students like you. Some are Math/Science majors or other students who really like math, others are just students who did well in Math 130/131 or Math 140/141 (and some of them never thought they'd do well enough in the classes to be an ML or that they'd be interested!). The ML's are not perfect. Ultimately, you are responsible for your own work; the ML's try their best, but sometimes they make mistakes. If there is a mistake on your paper, please don't blame it on your ML.

If you have a problem with your ML or other members of your study group, first try to work it out with the person or people involved. If you can't, feel free to see your instructor about it.

What if I get stuck?

You might be unfamiliar with the kind of homework that we often have in *Concepts and Processes*. Lots of time math homework involves finding a similar problem in the examples in a book and then copying the steps. Most of our homework won't be like that. You will often have new problems to try.

Sometimes *Concepts and Processes* students think that if they look at a problem and don't know how to do it right away, that then they can't do it, so they quit and figure that the teacher will show them how to do it next class. You might think that if you can't do a problem right away, then you don't know how to do it, and so you have to ask for help.

Remember, however, that in *Concepts and Processes* one of our main goals is to learn how to approach unfamiliar problems. We expect you to work on your homework, not to give up quickly. Your class will discuss many problem-solving strategies, here are some things to think about if you feel stuck and want to quit working on a problem:

- Do I really understand the problem? Can I restate it in my own words? If not, what is the confusing part? Is it a word I don't understand, a concept, etc.?
- Can I find the information I need?

- Can I solve a part of the problem?

- Can I solve a simpler version of the problem? What if I used smaller numbers, a simpler picture, etc.?
- Have I seen any problems like this? How did I solve them?
- Can I draw a picture? Make a table? Make a graph?
- Can I guess a solution, and then check my guess? Can modify my original guess to make a better one?
- Can I work together with a classmate?
- Have I explained myself well enough to convince a skeptic?

There is another list of problem solving strategies on the inside of your *Explorations Manual* that you might find helpful.

These problems are not all or nothing, and the goal isn't just to get the right answer. It is much better to make some progress than to quit.

What if I'm having trouble in the class?

It is better to take care of trouble sooner than later. You have many resources available to you. You can make an appointment with your instructor or just talk to him or her before or after class. It is part of our job to meet with students out of class, and we are available for one-on-one work. We have many students, however, so there is a limit to how much time we can work outside of class with you.

You can also get help from your ML or a tutor. Please remember that your ML is also a student and he or she has committed to leading a study group, but not to helping you whenever you want help (even if s/he lives in the same dorm that you do). Please respect your ML's time; if you would like to meet with your ML one-on-one, you should make an appointment. Your ML might not have time. Another alternative is to go to the Office of Academic Advising and ask for a peer tutor. There are many math tutors signed up with the office. If you have a learning disability or think you might have a learning disability, the Office of Academic Advising also has a specialist who can work with you.

What if I think I'm in the Wrong Class?

If you are in Math 130 and think you'd rather take Math 140, the first course in the intensive, two-semester *Concepts and Processes* sequence, you should contact me immediately to see about taking the entry exam for Math 140 (I can be reached at x2230,

in ACW 210, or at dborkovitz@wheelock.edu). If you passed the test to get into Math 140, but decide you'd rather switch to Math 130, you can switch, as long as there is room in the new section.

If you decide not to be a teacher, and it's near the beginning of the semester, you can switch to Math 120 if there is room. If it's near the end of the semester, you can finish the course, which will still count toward your mathematics requirement.

What if I have other questions?

Please feel free to ask. I am also interested in feedback on this guide: both at the beginning and at the end of the semester. Remember, communication is one of our goals, and it can be hard for your instructor too. If something here isn't clear to you, then it probably isn't clear to others too.