Chapter 4

Ownership
Taking Responsibility and Showing Initiative

You cannot teach a man anything; you can only help him to find it within himself.
~Galileo Galilei

Why did you become a mathematics teacher? Odds are that you found joy in the subject and wanted to share it with others. Perhaps it was because of the beauty found in a formula that explains why a phenomenon occurs in nature. Maybe you are curious and love to solve problems or puzzles. Or, you like the elegance in the language of mathematics and the certainty it brings. As educators, we would like to see a similar passion grow within our students for learning mathematics. Through the second pillar of PROWESS, students' ownership in their own education, will learning take place.

To spark this interest within our students, both faculty and students first need to have a common understanding of what learning is. One perspective is that learning is both a process and a product. It is an individual, internal, and personal activity. We cannot learn for another person. The learner must take responsibility for learning as it can only reside within the individual (Milton, 1973). By the time students reach our classrooms they often have an improper view of what learning is. They believe in a dualistic ideal that learning is about determining right or wrong instead of realizing that learning can be contextual and relative (Perry, as cited in Thoma, 1993). Too often, they also are waiting for extrinsic motivation instead of relying on their own intrinsic motivation to learn. Several studies have shown students who develop extrinsic motivation do not achieve at as high of levels as those who develop intrinsic motivation (Lemos & Verissimo, 2014; Pulfrey, Buchs, & Butera, 2011). It has also been shown that students with intrinsic motivation pursue subjects to higher levels and are more likely to persist through completion (Stipek, 1993).

> *Consider the contrasting stories of two students in a Beginning Algebra class. Both John and Lola enrolled in the class because it was required for their degree programs. John was promised a new car by his father if he completed the course with a grade of B or better. Lola, on the other hand, was a returning student with no such promise made to her. John dropped out of class before midterm whereas Lola completed the class with a grade of A. In this case, extrinsic motivation was not enough to encourage John to even do his homework. Lola understood the value of learning and completed her associate's degree.*

As faculty, it is our responsibility to guide students to find this motivation. Instead of luring them with extrinsic motivational processes, which shift their focus to valuing the consequences of task

completion, we should assist them to focus on valuing the task itself (Kohn, 1993). However, first, we need to look at what the expectations should be of our students as learners before we investigate how to help them meet these outcomes.

Student Ownership

The best faculty who "achieve[ed] remarkable success in helping their students learn in ways that make a sustained, substantial, and positive influence on how those students think, act, and feel" (Bain, 2004, p. 5) do so by cultivating three components of student ownership of learning

1. **Discovery**. An ideal classroom is where students are active participants in formulating conjectures, developing strategies for solving a problem, engaging in investigative tasks, or analyzing data. It is through these guided investigations that learning begins to take place.

2. **Responsibilities**. As students begin the journey of taking ownership of their own learning, they have responsibilities that they may assume on their own and others to which they may need to be directed. It is imperative that students clearly understand the objectives and goals of a course and are aware of the rubrics used to assess the quality of their work. It is a matter of fostering trust between the student and the teacher. This trust is that student can expect that the teacher will provide the assistance needed to accomplish the goals of the course and vice versa, that the teacher can expect that the students take responsibility and will meet the requirements set forth to achieve those goals.

   Arguably, the most important responsibility for the student is meaningful self-assessment. Students must recognize assessment as an integral component of the teaching-learning process and not just a means by which instructors assign a grade to their performance. Feedback garnered from a variety of assessments can help students better understand what constitutes an appropriate-and-complete response to a task, and assist them to develop their confidence in performing self-assessments. The ability to assess one's own work effectively is an important life skill, and of great value in the workplace.

   Self-assessment is a process in which students reflect on the quality of their work, compare it to explicitly stated criteria, judge how well their work reflects the criteria, and make appropriate revisions. Also, it is a formative process that informs students about what part of their thinking and subsequent work require revisions and improvement. Some strategies (whether prompted by the instructor or initiated by the student) that students may use to develop effective self-assessment practices include

   - reflecting on the knowledge they already have that might assist them in new situations
   - drawing from previous work that may relate to new circumstances
   - using graphic organizers, which organize facts, concepts, ideas, or terms in a visual or diagrammatic way so that the relationship between the individual items is made clear
   - evaluating their own progress to recognize what they do and do not understand
   - using rubrics (when provided) to evaluate their progress during an assessment or activity.

3. **Continued Learning**. The goal of each student should be deep learning: that is, "develop initiative multiple perspectives, think about their own thinking that they tried to understand ideas for themselves; that they attempt to reason with concepts and information they encountered, to use material widely, and to relate it to previous experience and learning" (Bain, 2004, p. 10). A student's journey to meet this goal will encounter accomplishments as well as setbacks. Students need to be able to accept failure or mistakes as an important part of learning. As the entrepreneur Malcolm Forbes (1978) once said, "failure is success if we learn from it." Recent studies have shown that when mistakes are made, the brain grows (Moser, Schroder, Heeter, Moran, & Lee, 2011). One type of response or spark observed in the brain is simply due to the conflict between a correct response and an error; it is not necessary that a person is aware that they have made a mistake. The second response is the reflection of the conscious attention to the mistake. According to Dweck (2006), people with growth mindsets have greater brain activity to follow mistakes. Although such people do not exactly enjoy failure, they are less miserable because they are not defined by their mistakes. They understand that the path to success will have failures along the way and they are comfortable facing them, so long as there are opportunities to learn along the way. It is through persistence that brain growth occurs and learning takes place.

When students take initiative of their own learning, the results can sometimes have a positive ripple effect for other students as is demonstrated by Kyela's story.

> *Kyela, a beautician pursuing her associate's degree, enrolled in a numeric skills class as a result of her performance on the college's placement test. She was understandably anxious about her math abilities, but she took ownership for her learning. As the semester progressed Kyela gradually took responsibility not only for her own learning but for that of the members of her group. Eventually she organized Sunday morning study sessions at the local coffee shop for anyone in the class to attend. As a result of her actions she achieved a grade of A in the course and the average grade in the class exceeded the average grade of the other sections of the same course that semester.*

Faculty Fostering Student Ownership

In general, faculty should be working towards empowering students to take ownership of their learning by promoting self-regulated learning. Students should take control of and evaluate their own learning through the phases of task perception, goal setting and planning, implementation, and adaptation (Winne & Hadwin, 2008). Faculty should be guiding and engaging students in activities that foster discovery, responsibilities, and continued learning. According to Mortimer and Scott (2003), there are three tasks for the instructor in the student learning process:

1. introduction of concepts
2. support for the development of meaning
3. provision of opportunity for transfer of ownership, practice, and application to student

For the first task the instructor must be prepared to use a variety of ways to introduce a concept. The primary focus should be on fostering curiosity within the student. By providing students with open-ended questions or utilizing inquiry-based learning techniques, instructors are supporting the students' intellectual need to understand a concept so that they are better motivated to learn it (Harel, 2013). If done correctly, students will be working on the discovery component of ownership.

For the second task, the key word is "support". Faculty must be patient, supportive, and available to help when students are frustrated or confused, but still allow them to struggle and make mistakes. It is vital that the instructor does not "do all of the heavy lifting" for the student. When students ask for help, a possible response is "let's think about this for a minute… Do you want my brain to grow or do you want to grow your brain today" (Frazier, 2015, para. 13)? Faculty need to know when and how to intervene when work is headed in the wrong direction and be able to use good questioning techniques to redirect students rather than giving them immediate answers. Class activities should guide and direct them to begin to assume responsibility for their own learning. Students must have a variety of opportunities to develop confidence in their abilities.

When utilizing group work, faculty must make sure that it is not just a way to have work done faster, but that individual ownership is taking place. Consider Beth, an instructor who utilizes the flipped model of teaching so she has opportunities every class period to take on a guiding role while students are engaged in group work. Her role has evolved over time as she has reevaluated what level of ownership the students have in the activities. Initially, her first semester of teaching was just spent answering questions, but in time she began to also do "interventions". As she walked around the room, she pointed out possible errors in logic and asked groups to reexamine their thinking, thus encouraging **group** ownership. However, she realized that was not enough. Now, each semester she works at incorporating ideas that lead to **individual** ownership.

For the final task, the transfer of ownership to students happens in a variety of ways. Faculty can assist students to take ownership at the beginning of a course by allowing them to have a voice in how the course is structured. For example, Judy, a mathematics instructor, often involves students in the development of her course syllabi (Barkley, 2010). They determine aspects of the syllabus such as expectations and the consequences of not meeting those expectations when doing group work. She also provides them the opportunity to choose from a variety of learning activities that satisfy the course objectives.

Throughout a course, it is important that an instructor ensures that students understand the objectives of the course and are able to meet them. One example of how to achieve this is the method that Kevin uses in his classroom.

He has created a checklist of objectives for his students to use as a way to prepare for exams. After finding out (through surveys) that the students were not using them, he looked for other ways to enforce this idea. He made two changes to the checklist. In upper-level classes he added the words "I can" at the beginning of each objective. He required students to look at the checklist at the end of each activity or class period to see where they stand. In his developmental courses, he has students reflect some more; they must check one of three statements for each objective as suggested by Boaler (2016):

- *I can do this independently and explain my solution path(s) to my classmates or teacher.*
- *I can do this independently.*
- *I need more time. I need to see an example to help me (p. 152.)*

Students hand in the checklist when they take the exam and are then required to reflect on their perception of their knowledge once the exams are handed back.

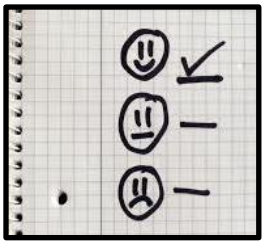
It is a faculty's responsibility to design activities and assignments that will guide students to master course objectives. Students need to first try out and practice new ideas in familiar situations and then move to applying the knowledge to new and unfamiliar contexts (Mortimer & Scott, 2003). These contexts should include applications that go beyond the typical story problems. Students need to be

presented with problems in a way that requires them to determine what technology, techniques, or methods to utilize and how to use them effectively. In an effort to improve success by engaging students in meaningful applications, a community college system in Florida contextualized their Intermediate Algebra and College Algebra courses. Business faculty were involved in the creation of real-world problems upon which the content was built. Mathematics faculty needed the support from business faculty to find realistic and meaningful applications. The success rate of students was 10% above those of students in courses not incorporating these problems.

Last, providing a variety of assessments will help students recognize areas in their learning they need to improve. Feedback garnered from different assessment tasks is vital. Instead of assigning endless homework problems, it may be more beneficial to ask students to answer some reflection questions, as suggested by Boaler (2016):

- What was the big idea we worked on today?
- What did I learn today?
- What good ideas did I have today?
- In what situations could I use the knowledge I learned today?
- What questions do I have about today's work?
- What new ideas do I have that this lesson made me think about (p. 158)?

We illustrate these suggestions with an example from Barbra. She utilizes emoticons to have students gauge their understanding of a topic. Her quizzes begin with students choosing a smiley face, plain face, or sad face to indicate how they think they will perform. Next, they take the quiz and then indicate (with the same emoticons) their views of their performances. The entire class then goes over the quiz and students correct their work and make comments about what went wrong (or right). Afterwards, they use emoticons once more to indicate their actual performance. Students then write a few statements regarding what they need to do based on their results from the quiz. Most of the responsibility of the assessment is on the student, but Barbra does go over the quizzes and indicates mistakes students may have overlooked. She also praises them for their work and self-assessment as appropriate.



Faculty Ownership

We have taken a brief look at student ownership and ways in which faculty can guide students in the process. Now we focus on faculty and how we can take ownership of our roles. When examining the faculty role in education, a large part involves the other pillars of PROWESS: mathematical proficiency, engagement, and student success. For this part of the discourse, we will examine three key areas in which faculty can take ownership: creating a learning environment, taking an active role in course design, and becoming a reflective practitioner.

Learning Environment

The Learning Environment involves instruction and assessment practices intentionally developed to help all students achieve course (as well as individual) goals. It is a place where they experience mathematics with the guidance of faculty. While the word "classroom" is often used to refer to the learning environment, we prefer the broader term "learning environment" to include all settings in

which faculty and students interact, including the online environment. First, looking more broadly at the idea of Powerful Learning Environments, Merrill (2002) summarizes four characteristics of learning environments that seem to be common in current instructional theories: prior knowledge and experiences of the student must be activated in order to build new knowledge on pre-existing knowledge, new skills or knowledge must be demonstrated to the student through modelling, the student should have the opportunity to apply their new knowledge and skills, and the newly acquired skills and knowledge must be integrated into real-world activities. In general, the learning environment

- Incorporates the necessary physical space, materials, technological resources, and support staff who facilitate effective learning of mathematical concepts and skills.
- Encourages student-faculty contact.
- Incorporates innovative teaching and learning strategies that use technology and activities designed to promote active student engagement, meaningful discourse, and cooperative learning.
- Fosters active student engagement in mathematical thinking and encourages student creativity and risk-taking.
- Promotes a culture that values the diverse interests and backgrounds of students.
- Addresses diverse talents and ways of learning and teaching.
- Is designed to be effective in developing PROWESS, which includes increasing students' persistence, grit, and communication skills.

Narrowing the focus, we suggest four areas of concentration for providing an effective learning environment: method of instruction, teamwork, diversity, and learning outside of the classroom.

The *method of instruction* is a personal decision for faculty. Instructors should be aware of innovations in the area of instruction and be willing to adjust their methods as appropriate. Any strategy used should

- Support student engagement with the material, especially considering the diverse learnings needs of the students.
- Be thought-provoking.
- Include clear communication and explanation of topics and goals (Cai, Kaiser, Perry & Wong, 2009.)
- Be focused on building mastery of the learning outcomes.
- Use questioning to promote active learning and to measure student understanding.
- Incorporate technology that is appropriate for the task at hand.
- Use multiple assessment measures (Huba & Freed, 2000.)
- Provide both formative and summative feedback that are low-stakes.
- Take into consideration changes that might need to be made for distance learning courses.

The second area of concentration, *teamwork*, is complex but vital. The ability to work in a team structure is among the most valued skills employers need when hiring new employees (Adams, 2014). Facilitating successful teamwork requires training on the techniques and justification for the specific type of group work. Based on work done by Johnson & Johnson (1999), when incorporating group work we suggest five aspects to focus on

- Structure for positive interdependence: Group interaction is necessary for successful resolution of the question or task, and for linking individual success to the success of the group.
- Structure for interaction: Group interactions include discussing solution paths, important concepts, and connections to prior knowledge, as well as facilitating help and words of encouragement when needed.
- Structure individual accountability: Students are held accountable for their share of the work in the group.
- Structure social skills: Group interaction requires interpersonal, social, and collaborative skills. Students must be provided guidance on how to effectively interact in a small group.
- Structure group processing: Group members discuss effectiveness in reaching their goals and in working together.

The third area of concentration when designing a learning environment is *diversity*. Faculty must recognize that diversity manifests itself in a variety of ways: age, gender, ethnicity, socio-economic background, and academic preparation. To address issues related to diversity, faculty should

- Have high expectations for all students and clearly communicate those expectations (NCTM, 2000; Jamar & Pitts, 2005; Center for Community College Student Engagement [CCCSE], 2008).
- Use best practices to increase student success rates, which include using diagnostic assessment to counteract poor performance and vary the instructional styles in the classroom (Holloway, 2004).
- Strive to encourage underrepresented groups.
- Consider diverse languages and cultures as assets to mathematical knowledge and highlight contributions made from such groups (Holloway, 2004).
- Advise students about the availability and appropriate use of academic support resources.
- Collaborate with appropriate support service personnel to respond to the needs of students with disabilities.
- Be sensitive to situational factors in which many students are balancing family, job, and academic responsibilities; provide constructive suggestions and support for overcoming those challenges.
- Be sensitive to the impact of mathematics anxiety and teach students to employ remedies related to mathematics self-efficacy (Pajares, 1996):

    - Make explicit the importance of mathematics self-efficacy to student success including the four sources of self-efficacy: mastery experiences, vicarious experiences, physiological states, and social persuasions. Understand that there is a cyclical relationship between the four sources (Usher & Pajares, 2006, 2009).
    - Facilitate confidence in students by cultivating new mastery experiences. Since mastery experiences is the best predictor of self-efficacy, faculty need to rebuild mathematical competencies to scaffold learning (Usher & Pajares, 2006, 2009; Zientek, Fong, & Phelps, 2017).

The fourth area of concentration highlights the idea that the learning environment is not just what takes place inside the classroom, but also *outside of the classroom.* This encompasses a wide variety of considerations

- Regularly require students to work on mathematics outside the classroom. This will include expecting students to prepare for class as well as to practice what is done in class. Instructors will encourage these behaviors with timely feedback (Huba & Freed, 2000).
- Encourage appropriate interaction with students and between students inside and outside of the classroom.
- Encourage explanations of concepts to peers and various audiences such as professionals and laypeople (Angelo, 1993; Huba & Freed, 2000).
- Provide service-learning opportunities for students in your courses.
- Foster undergraduate research.
- Be available outside of the classroom to assist individual students.
- Be involved in the design of and the decision-making about physical spaces that support mathematics instruction (such as tutoring centers).
- Identify and recommend necessary technology that assists students in exploring and mastering mathematical concepts. Technology should be available and accessible to all students.

Course Design

Most often, course design refers to the length, content, and structure of courses, but in this document, we will examine it in a broader sense to include components of instructional design. The goal of a good course design should be to foster learning. Decisions about course design should articulate how the curriculum is going to be delivered to students in ways that promote PROWESS. These decisions are best viewed as a joint responsibility by all faculty involved with a course, including a joint decision on ranges of acceptable variation between sections and delivery methods. We provide suggestions (in no particular order) for course design

- Assure that learning outcomes in mathematics distance learning sections are consistent with those of similar mathematics courses taught in classrooms.
- Include a variety of assessment techniques such as performance tasks, interviews, open-ended questions, observations, projects, and portfolios in addition to the traditional paper-and-pencil tests.
- Utilize various sources for course materials. These might be traditional textbooks, e-books, or Open Educational Resources; the selection of these materials should be based on criteria related to quality, effectiveness, and affordability.
- Offer alternatives for course duration. Traditional semester or quarter length courses should be combined with alternatives to provide the best student experience. This might include co-requisite structures, fast-track courses, and individualized learning.
- Faculty should be open to different styles of teaching; effective course design incorporates diverse styles within and across courses.
- Provide support for students to develop a more diverse set of learning skills.
- Ensure that assignments and assessments address the needs of a wide variety of students, both culturally and physically. (For this purpose, we include learning disabilities in the physical category of diversity.)
- Address and correct issues connected to students' misconceptions.

- Use learning technology in all mathematics courses to support curricular goals and course outcomes.
- Use appropriate technology as a tool to aid students to discover patterns, test conjectures, and validate conclusions.
- Use technology that is accessible to all students.
- Make available technology applications and software that students may use in other courses as well as their daily lives.

Continuous improvement of course design can be achieved by using effective assessments in which faculty identify assessment tools linked to desired student learning outcomes and proceed through a four-step implementation cycle of planning, gathering relevant data and evidence, interpreting them, and using results to make informed instructional decisions. Instructors should participate in the development and assessment of not only individual courses but also how the courses contribute to general education outcomes in mathematics.

Becoming a Reflective Practitioner

Instrumental to faculty ownership is to be a reflective practitioner who examines curriculum and teaching practices to identify areas that need improvement. We offer suggestions for becoming a reflective practitioner

- Consider whether students are taking ownership of learning in the classroom. To do so requires a clear understanding of what ownership means and how to assess it.
- Continually review courses and curricula and determine processes for continuous improvement.
- Keep abreast with current research on learning and teaching, and incorporate findings in courses.
- Faculty should be encouraged to craft and try an action research project.
- Foster a growth mindset in students.
- Faculty should examine teaching practices through four complementary lenses—autobiographical experiences as learners, students' views, colleagues' perceptions, and educational literature (Brookfield, 2002).
- Faculty should be encouraged to share ideas with each other. This can be done at the department level through monthly faculty meetings where participants can take turns to share information about specific courses, or general strategies on teaching and learning. New ideas can also be acquired through professional conferences, or on IMPACT Live!

Department and Institution Ownership

As faculty take ownership of individual responsibilities for the learning environment, course design, curriculum, and assessment, it is the role of mathematics departments and institutions to support faculty in their teaching. By faculty uniting as a department, they are more likely to influence their institutions into listening to and acting upon the needs of the faculty. The institution needs to work with the faculty to determine the best course of action given the resources that can be made available.

One area that departments and institutions have the most influence over is in providing a supportive learning environment consisting of contemporary classrooms, mathematics tutoring labs,

learning centers, counselors, and service for students with disabilities, to name a few. Learning environments should be adaptable to the needs and characteristics of students. Classroom layouts, which include furniture in the case of traditional settings, the design of virtual courses, and technology resources for both, all contribute to the learning of mathematics. As such, departments and institutions should

- Supply the necessary equipment and training to create classroom environments that maximize the learning of mathematics.
- Ensure that students have access to any needed technology, such as computer software and hardware, digital recorders, calculators, and videos.
- Design classrooms (real and virtual) that follow guidelines, such as those addressed in Universal Design for Learning (CAST, 2011).
- Support best practices in face-to-face, online, and hybrid/blended classrooms.

Departments and institutions must create environments that support both learning and social interaction. Learning centers should be welcoming, accessible, and staffed with well-trained tutors. Departments and institutions should

- Provide adequate space and resources for peer and professional tutoring as well as mathematics resource centers.
- Have strict requirements for tutors (for example, they are only to tutor courses for which they are qualified).
- Establish sufficient training opportunities for mathematics tutors, supplemental instructors, and student support staff.
- Offer workshops for students that include (but are not limited to) mathematics study skills, anxiety reduction, and technology usage.
- Make learning resources available at times suitable for students (including nights and weekends).

Another area that departments and institutions have the most influence over is the instructional materials that faculty use in their classes. The purpose of mathematics courses and programs in college is to develop students' mathematical proficiency with the intention of preparing them for other courses and the workplace. Departments and institutions must oversee curriculum development and assessment in mathematics courses and programs. They must ensure that decisions are based on the needs of the local student population but that results also align and agree with national trends and visions as well as curricula at transfer institutions.

A curriculum must be designed for today's students and tomorrow's society. It must effectively meet the needs of as many academic paths and disciplines as possible. In particular, attention should be paid to the influence of technology, research on student learning, mathematics content, and skills needed for successful careers and responsible citizenship. Thus, departments and institutions should

- Work with the faculty to determine outcomes for each course, while conversing with outside sources such universities, businesses, legislatures, and national organizations.
- Ensure that outcomes in the developmental mathematics program include quantitative literacy, which is necessary for student success in future college-level courses.
- Encourage collaboration among departments regarding instruction and assessment of mathematics outcomes embedded in non-mathematics courses.

- Implement periodic reviews and redesign of student learning outcomes.
- Evaluate placement and prerequisite requirements to align with course outcomes.

The next area in which departments and institutions must recognize their responsibility and role is in fostering and providing professional development opportunities by the establishment of an effective professional development program. Participation in professional development activities has a measurable impact on teaching. Keys to providing an effective professional development program include (Morley, Jamie & Zutes, Spring, n.d.)

- obtaining faculty engagement and ownership
- making the process easy to administer
- tying it to the Annual Performance Evaluation
- being consistent and flexible
- rewarding active participation
- encouraging faculty with similar goals to attend activities together
- making all forms electronic, easy for faculty to modify and easy for managers to track
- creating a faculty portfolio location on employee portal or LMS.

The final area that departments and institutions need to take ownership in is that of assessment. Curriculum assessment provides mathematics departments with data to make informed decisions about course content and student learning. It is an ongoing process by which a college or department assesses what mathematics students know at the end of their course or program. Results should be analyzed extensively and discussed, as well utilized to revise and improve curriculum and courses. Departments and institutions should

- involve full-time and part-time faculty in designing and implementing course and program assessments
- link department-wide assessment instruments to course outcomes
- assess courses frequently
- plan for and conduct periodic assessment of all mathematics course outcomes
- analyze assessment data and use the results to improve student learning
- retain records relating to various course-wide interventions to review and reflect upon.

Working Together

Students entering two-year colleges bring with them a variety of ideas of what learning is and what their role is in order to be as a successful student. They, as well as faculty, departments, and institutions, should assume ownership in their respective roles, yet work collaboratively toward the same goal of academic success. Opening effective continuing lines of communication is key to each group's ability to take ownership of their role.

Are you looking for ways to heighten your ownership of your role as a member of the mathematical community? Would you like to learn about more ways to foster ownership in your students? Do you already have great information or activities involving faculty or student ownership? Head to AMATYC.org/IMPACTLive and find innovations your colleagues using or contribute innovations and ideas of your own.

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