Improving Educational Outcomes in Manufacturing Engineering Technologist and Technician Education

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Contextualized Instruction Approach to Developmental Math in Manufacturing at MATC

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Issue: At Milwaukee Area Technical College (MATC), cutoff scores of Accuplacer math placement test were raised to admit students who applied for fall 2013 admission for the Welding and Machine Tool diploma programs. This new policy prompted members of the METTE Networked Improvement Community (NIC) at MATC to engage in new innovations in math learning and teaching to help prepare students who fell under the newly implemented cutoff scores. The first phase of these innovations involved adopting a contextualized approach to teaching math. A student-centered approach, contextualized instruction connects subject matter content to real world situations and motivates students to draw upon their prior knowledge and experiences (Berns & Erickson, 2001). Two METTE instructors at MATC implemented the contextualized approach in their math courses in the fall term of 2013 by creating a 1-credit elective elementary algebra course and a workshop for students in Welding, Mechanical Design and Electronics. Three researchers from UW-Madison's METTE team conducted observations and interviews in these classes to understand the extent to which this contextualized approach shapes student learning and engagement.

Specifically, we ask: Does a contextualized instructional approach to developmental math courses effectively help students improve math skills?

- In what ways does the contextualized approach shape students' math learning experiences?
- How could this practice influence the design and implementation of developmental math courses in the future?

Design: UW-Madison researchers observed one full-session of each course and interviewed all students and instructors involved in the course on the MATC Milwaukee campus in November, 2013. Four students were enrolled in the elective math class held in a computer lab, where computers were available to each individual student. Students met with the instructor once a week. The 6-week workshop enrolled five students and met four days a week. Students were each equipped with a workstation where they worked independently on a project. College-level math proficiency, along with knowledge of machine operation, was required to complete the project. Both instructors are full-time faculty members and have been teaching at MATC for many

years. Prior to joining MATC, they both worked in the manufacturing industry. All students were informed about the observation and interviews prior to the visits of the UW-Madison team and agreed to participate.

Findings:

- Class Atmosphere

Students in the elective math class described the class as "warm and friendly," and they felt comfortable sharing ideas and raising questions. Despite the fact that the computer lab was not physically set up to facilitate interaction, students referred to this lab their "gathering place" and "home room." In the workshop class, students all arrived on time and started working at the machines immediately. They were working on their own project turning a metal cube into a part that was illustrated in a blueprint on the textbook. The instructor walked around the room and checked every student's progress as well as adherence to safety standards. Students indicated that this environment helped them concentrate on their work and it was easy to find help from the instructor or peers.

- Students' perception of mathematics

Students in the elective math class were aware of their under-preparedness in math and did not hesitate to admit that they were intimidated by the breadth of math topics. One student noted during the interview:

> *There is just too much information. It is like you go to a restaurant, and they give you a big menu. It is hard to pick out something specific, because you have so much. By being so much, it is intimidating.*

Nevertheless, they were motivated to learn:

> *Don't just give it to me and let me pass a C or D. I don't want to just pass by the basic knowledge of it. If I don't understand something, guess what, I want to know.*

The instructor of the workshop also indicated during the interview that students were afraid of and uncomfortable with using machines at the beginning of the academic term, showing a low level of confidence in applying math and other relevant knowledge to tasks at hand. It appeared that since then, this sense of intimidation had started to disappear. During the class observation, researchers found that students were all using machines with no fear. They were comfortable asking questions, reporting mistakes they had made, and open to discussion about their mistakes with others.

It is worth noting that, with these supports, students not only seemed to have improved their math skills, but also experienced an increased level of math self-efficacy. As a student in the math elective class expressed:

> *When you get math, it gives you a personal up boost. You know, like I can do math. It is not everybody can do math. It is more*

personal, it is more like the ego boost.

- Student-Faculty Interaction

In the elective math class, students indicated that the interactive nature of instruction and peer collaboration were key to their motivation and persistence in this class. As one of the students pointed out:

> *That is why I say this is like a "home room." This is something every student should have, something where you can go and get your foundations… If there were seven or [more] students, it still wouldn't be bad, because you still have enough interaction with the teacher.*

Moreover, students agreed that interacting with the instructor in a positive manner contributed to their improved learning experiences. Students also appreciated the instructor's effort to assist students' academic needs in general:

> *This is the only class like this [where] you can have that hands-on benefits and the connection with the teacher.*
>
> *This is what [this class] does. It helps you work out what the problem is, whatever the problem is. If I got a problem in welding, I got [the instructor] to help. If I got problems in English, I would go to [the instructor], although I don't know how much [the instructor] knows about English. But [the instructor] can direct me to the right position.*

In the workshop, the instructor closely followed everyone's progress. Students seemed to be very comfortable interacting with the instructor, demonstrating a close relationship. The instructor tended to engage the students in long conversations if they encountered math problems in the project. Instead of offering answers directly, the instructors provided hints and tips on formulas, asked a series of short questions, and led the students to come up the correct answer on their own, step by step. Students indicated that such conversations were challenging but helped them learn how to cope with similar problems in the future. This level of comfort that seemed to have led to the open and conducive learning process was largely attributed to the instructor's desire to develop great rapport with students:

> *[Students] are no difference as my kids. I am proud when I see their progress… I have high expectations for them, and I provide them the support they needed to reach my expectations.*

- Connection with Course Content

Students in the elective math class indicated that this class was closely tied with the program, and perseverance seemed to be the key to success:

> *If we don't need this math in everyday in whatever the field we are going to, we don't need it… Because if we cut something, we need to know why do we have to do this in order to get to this point… A lot of the math classes they don't*

actually do that.

[The instructor and I] write [the question] out and we go through it. And we might go through it a couple of times, but we get it. That's the thing.

The instructor of the workshop indicated, "Most of the time students have the math skills but do not know how to use them." The instructor's solution for this issue was the use of a "trinity: math, blueprint, and workshop." The three areas helped students visualize and learn math content by practicing in the workshop. "Breaking knowledge down to beginners' level" was the common technique the instructor used to help student understand. The instructor summarized the teaching process as "I show, you try, and I help." Students also favored the "question-answer, more questions, refine answer, and try it yourself process."

Implications:

These findings primarily suggest that contextualization effectively promoted students' learning in the two developmental math offerings at MATC. Through making connections between math concepts and future academic or professional goals, students were motivated to learn and to apply the skills they have learned to real-life situations. Second, creation of a climate that encourages students to ask questions revealed to be critical for students learning in developmental math and applying math in machine operation. Finally, a small class size was revealed to be one important factor that contributes to positive learning experiences.

Institutions and policy makers could consider contextualized instruction as a viable approach to teaching developmental math classes. Curriculum and instruction materials should be created based on students' needs and fields of study. Class size should be also taken into consideration, although a bigger class size would still be manageable. In addition, instructors of contextualized courses should build strong rapport with students while maintaining high expectations and providing on-going support. It is also recommended that faculty facilitate cooperative learning and encourage students to learn in groups since students also clearly benefited from discussions with peers.

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