
What is Math-in-CTE?

Math-in-CTE is a professional development model that helps Career and Technical Education (CTE) teachers elevate the level of mathematics instruction in their CTE courses. This is accomplished by developing math enriched lessons through collaboration with a math teacher. Math-in-CTE has a researched pedagogical framework that provides structure for the math lessons and assures that the math content is dealt with explicitly.

Math-in-CTE teams have come from 83 Oregon high schools and 3 community colleges. On average, CTE students in those schools have been taught using 5 to 7 math-enhanced lessons. Previous studies have indicated that over 70% of the teachers who received Math-in-CTE professional development continue teaching the lessons after their initial workshop.

Math-in-CTE focuses on providing support in math instruction to students at any level. Some schools have extended the work in Math-in-CTE workshops to provide math credit through CTE courses. Although it would be difficult to determine what part Math-in-CTE plays in overall student achievement, 84% of schools who were involved in Math-in-CTE training showed gains in math achievement for CTE students.

The 5 core principles

Math-in-CTE professional development is based on five core principles that help determine fidelity of implementation.

1. Develop and sustain a community of practice. – The professional development requires that CTE teachers work with a math partner who becomes a math consultant for the CTE teacher. In addition, each school team works with teams in other schools to share and critique lessons that are developed.
2. Begin with the CTE curriculum and not with the math curriculum – A curriculum mapping process is used to identify the naturally occurring mathematics within the CTE curriculum. Beginning with the CTE curriculum rather than math standards helps maintain the CTE context in which math is being used.
3. Understand math as an essential workplace skill – By explicitly dealing with the math used in CTE, teachers acknowledge and promote to their students the need to understand mathematics in the workplace.

4. Maximize the math in CTE curricula – The math teacher works with the CTE teacher to identify the type and level of mathematics being used in the CTE course.

5. CTE teachers are teachers of “Mat-in-CTE” NOT math teachers – CTE teachers are not asked to take the role of a math teacher, but to consider a valuable support role.

Lesson Development

Lessons developed through the Math-in-CTE professional development follow a pedagogical framework that starts with the math addressed in a CTE context, gradually transitions to math instruction that looks more like what would be found in a math class, and finally assesses student knowledge of the math and how to apply the math. The pedagogical framework consists of seven elements.

1. Introduce the CTE lesson
2. Assess students’ math awareness
3. Work through the embedded example of math in the CTE lesson
4. Work through related contextual examples of math
5. Work through traditional math examples
6. Students demonstrate understanding of math application
7. Formal assessment of math skills

Workshop Content

Participants in the Math-in-CTE professional development spend up to ten days during the school year working as a community of practice to develop math-enhanced lessons. During the summer, teacher teams map the CTE curriculum, identify possible math-rich lessons, develop lessons, and share lessons with the entire group. This time provides each team with at least one complete lesson that can be taught early in the school year as well as a series of lessons developed by other teams that can be modified and taught later. Follow-up meetings during the school year allow teachers to share their experiences after teaching lessons, refine lessons, and develop new lessons.

ODE's Involvement

2006-2007

The National Research Center for Career and Technical Education (NRCCTE) offered their first technical assistance for Math-in-CTE at Lane ESD. This initial workshop was funded through a grant from ODE and from Jeld Wen. Career areas included construction and manufacturing.

2007-2008

A workshop was conducted at Lane ESD with technical assistance from NRCCTE and financial assistance from ODE. Prior to the summer workshop, an Oregon cadre consisting of ODE staff, university faculty, and CTE regional coordinators attended a training session at the NRCCTE headquarters in Minnesota. The purpose of the cadre was to develop an awareness of Math-in-CTE in preparation for development of a statewide plan for expanding Math-in-CTE in Oregon. The Math-in-CTE workshop focused on manufacturing and marketing.

2008-2009

Math-in-CTE Workshops were held in two different locations to broaden availability. At Lane ESD, the workshop focused on culinary and a workshop at Northwest Regional ESD focused on drafting. Both were supported in part by ODE. Clackamas ESD independently conducted a Math-in-CTE workshop for teachers in that region lead by the Regional Coordinator and teachers who had attended previous workshops. The Clackamas ESD workshop was funded entirely with regional Perkins funds.

2009-2010

Four workshops were held around Oregon and were determined by application from CTE Regional Coordinators. Lane ESD focused on automotive and health occupations. High Desert ESD in Redmond focused on engineering. A group of regional coordinators from eastern Oregon focused on agriculture. The Mid Willamette Education Consortium at Chemeketa Community College focused on manufacturing and agriculture. An additional workshop was held at Clackamas ESD and was independently funded.

2010-2011

Workshops were held in three regions chosen to expand coverage in areas with lower participation. In this case most groups were mixed CTE content. Workshops were offered through Portland Community College, Grant ESD, and Southern Oregon ESD. A fourth workshop was conducted by High Desert ESD but funded only with regional Perkins funds.

Outcomes

The long-term goal for Math-in-CTE is to improve mathematical achievement in students who have been taught using math-enhanced lessons. Early in planning implementation of Math-in-CTE in Oregon, ODE staff determined that replicating the controlled study originally conducted by NRCCTE would be costly and unlikely to generate additional useful data beyond that already provided by the initial research. Instead, the focus was to provide and support the professional development under the assumption that student outcomes would be similar to the results of the NRCCTE study. The focus in Oregon was to:

1. **Expand** - Develop a system to expand availability of the professional development,
2. **Maintain** - Maintain fidelity of the process,
3. **Sustain** - Provide a model of sustainability that would remove ODE as the primary provider.

Expand

Since 2006, 14 Math-in-CTE workshops have been conducted statewide. Eleven of those workshops were partially funded through grants provided by the Oregon Department of Education. Each workshop involves approximately ten days of training and collaboration. Three of those workshops were conducted using only support from local Perkins funds. The remaining workshops were partly funded through a grant from ODE.

236 math and CTE teachers have participated in the workshops representing 83 different high schools which are 38% of all Oregon high schools with approved CTE programs. Of all the participating schools, 33 have sent more than one team of teachers to a workshop. Schools are located in 27 of Oregon's 36 counties. Counties with no participating schools are generally very rural and have few schools with approved CTE programs. Each CTE teacher committed to teach 5 to 7 math-enhanced lessons in at least one CTE course during the workshop. Math teachers frequently express interest in using the developed lessons in their math courses.

Instructors and administrators from Clackamas Community College, Columbia Gorge Community College, Rogue Community College, and Treasure Valley Community College have participated in Math-in-CTE training at some level with the intention of integrating mathematics into CTE instruction at the community college.

Maintain

A set of workshop resources was developed to distribute to Math-in-CTE workshop providers. The resources include information about the professional development, tools to develop and critique lessons, and evaluation tools to monitor implementation of lessons.

Six regional coordinators and teachers have participated in training to be Math-in-CTE facilitators. The facilitators understand the fundamental concepts of Math-in-CTE and have assisted with workshops before leading a workshop. One of the facilitators is also a national facilitator for NRCCTE. The group communicates periodically to share thoughts and strategies.

Funds provided by ODE were contingent on using a trained facilitator and maintaining the fidelity of the Math-in-CTE process.

Sustain

The NRCCTE provided two years of technical assistance to develop Math-in-CTE capacity around the state.

Oregon now has a cadre of facilitators available to regional coordinators who wish to hold future Math-in-CTE workshops.

Online resource to support Math-in-CTE and other applied academic options are currently being developed in collaboration with Lane ESD, The Oregon Association of Career and Technical Education and High Desert ESD. The resources will include workshop materials, information about facilitators, and examples of lessons developed by CTE teachers.

Additional Outcomes

Math-in-CTE has spawned additional outcomes not specifically targeted by the professional development. These can be attributed to the partnerships that have been formed between math and CTE teachers as a result of Math-in-CTE.

The Salem-Keizer School District assembled a team of math and CTE teachers to investigate development of ways to award math credit to students who are in CTE courses that have elevated mathematics instruction. As of 2010, they have developed and started piloting math credit for Accounting and Early Childhood Education courses. In the process of developing those courses, the district has created policy that:

- Requires math professional development for CTE teachers who are offering math credit
- Requires CTE teachers who are offering math credit to have a math partner

- Identifies a methodology for determining the amount of credit awarded for applied math

A math teacher and a CTE teacher at North Marion High School have collaborated to develop an Engineering Math course that is taught by the CTE teacher. This work began as part of the Math-in-CTE training. The course offers 0.5 credits linked to Oregon High School Mathematics Standards in geometry. A pre and post test conducted in the course determined that students did improve understanding of math content in the applied course. The teachers are now developing a second course focused on civil engineering and its associated mathematics.

At Mountain View High School in Bend, a math and CTE teacher used their experience in Math-in-CTE to identify the mathematics and science standards taught in the automotive program. The high school offers math and science credit upon completing 2 ¼ credits of specific automotive courses. The same teachers are piloting an Algebra 1 course taught by the math teacher with supporting application taught by the automotive teacher.

CTE students' performance in mathematics has improved from 2007 to 2009. Although Math-in-CTE can't be linked directly to this improvement, it has elevated the interest in methods for improving mathematical performance. Gresham High School has attributed some of their improvement to Math-in-CTE. Of the 67 schools with teachers who have participated in Math-in-CTE and have available CTE data on mathematics performance, 56 have shown an improvement in math scores on OAKS testing.

The Office of Assessment and Information Systems (OAIS) is working with the Secondary and Postsecondary Transitions Team (SPST) to develop examples of applied mathematics work samples using problems drawn from Career and Technical Education. Four teams of math and CTE teachers who were originally involved in Math-in-CTE workshops have developed samples and collected student work. The samples are now being reviewed by OAIS.

Experience with math and CTE teacher partnerships has demonstrated that math teachers are interested in developing and teaching mathematics content in context. After consultation with the National Research Center for Career and Technical Education, ODE staff determined that there were few if any national models for providing context-based instruction in mathematics. This finding has resulted in an ongoing project to develop and test such a set of instructional materials. The project started in the summer of 2010 with nine participating high schools that have been involved with Math-in-CTE.

Additional Lessons

Math-in-CTE requires a significant time and financial commitment. Part of that commitment is associated with the community of practice that is so critical. Since 2006, there have been several small efforts to evaluate the effectiveness of the Math-in-CTE professional development using a shorter time commitment. The ideal time based on the original study is ten days. Oregon's experience indicates this can easily be reduced to nine days. Reductions beyond that seem to reduce the quality of team interactions.

The total cost of a regional Math-in-CTE workshop can exceed \$30,000. The contribution from ODE for each regional workshop has been \$10,000 and covers mostly direct costs of conducting the workshop. The greatest expense comes from providing support for travel, lodging, food, and substitutes.

The relationships between math and CTE teachers built during Math-in-CTE workshops can't be underestimated. Generally, math teachers are grateful to have other teachers support the work they are doing. CTE teachers find a valuable place to contribute to the overall goals of a school.

Math-in-CTE has served as a stepping stone to other student opportunities in applied mathematics. Although the focus of Math-in-CTE is not on offering credit, most of the recent activity in developing applied mathematics courses and credit options has evolved from the relationships formed by math and CTE teachers who participated in a Math-in-CTE workshop.