

CARNEGIE MATH
PATHWAYS
WestEd 

Narrowing the Distance in 'Distance Learning'

Lessons from Carnegie Math Pathways on
Designing for Student Success Online

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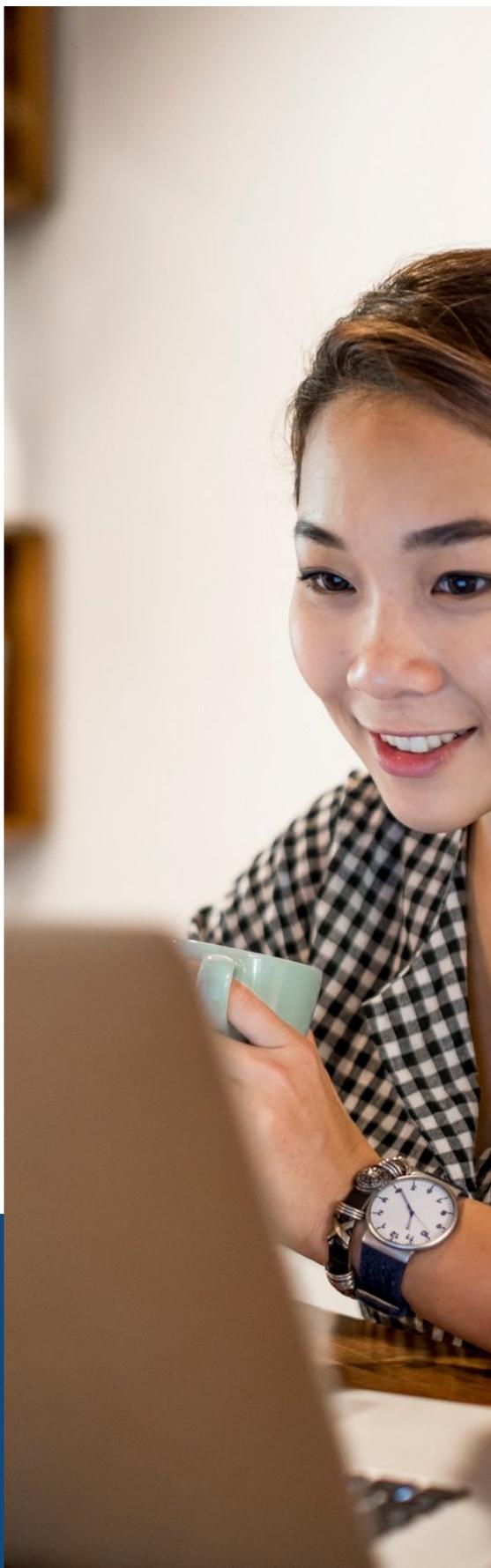
Charting a new path for online learning

In 2018, Carnegie Math Pathways partnered with educators and education technology experts to reimagine Quantway and Statway for the online space. Our goal was to help institutions meet the needs of students seeking more flexible course options by providing a high-quality online learning experience that would enhance students' self-efficacy as learners and increase their course success and completion. We did this by creating a uniquely engaging online learning experience that incorporates active collaboration and social emotional learning and that is just as effective as our highly impactful in-class course solutions.

Students in Pathways online courses succeed at the same rate as students in Pathways in-person courses. And students and instructors report that the collaboration component in particular is an important and meaningful part of the learning and teaching experience.

Since launching these courses, we've learned several important lessons about how to create a productive online learning experience that increases student success. Building a sense of belonging is key to course engagement, persistence, and, ultimately, success, and it requires connecting students not only with course content but with their peers and their instructors. We've made collaboration a centerpiece of our online learning design. In this brief, we highlight what well-designed online collaboration offers to students and instructors, and we provide recommendations for how to achieve it.

Building a sense of belonging is key to course engagement, persistence, and, ultimately success, and it requires connecting students not only with course content but with their peers and their instructors.



The need to rethink the standard approach

Every year, large and growing numbers of students pursue their education online. These students include those managing work and family responsibilities and those for whom online is the preferred or only means for accessing education. Although expanded distance learning options offer students the flexibility to participate in and increase their access to education opportunities, research shows that failure and withdrawal rates are sharply higher in online courses, including developmental mathematics courses, than in equivalent in-person courses.¹ The need, therefore, remains for high-quality online math learning experiences that help students persist and succeed, particularly students who need additional support.

Meeting this need requires rethinking the online learning experience. The vast majority of online math courses have been designed to support independent and asynchronous learning. Yet this learning model, which is typically coupled with a predominantly direct instructional approach, often does little to create the kind of supportive learning environment that can enable student success. Instead, this model leaves many students feeling isolated in their learning, leading to disengagement and an inability to complete the course.

Low engagement and low outcomes in traditional in-person math classes are what motivated Carnegie Math Pathways to reimagine math teaching and

learning in the classroom. Together with a network of educators and researchers, we developed and tested a holistic instructional model that upended the traditional lecture-based approach and instead centered on a collaborative and inclusive class experience that supported students in actively engaging in the learning process with their peers, building on their individual strengths and knowledge. What we learned from this was remarkable. When students worked together on relevant problem tasks and instructors provided supports to build community and nurture students' belief in their ability to learn math, course outcomes increased dramatically.

Evidence from our in-person courses led us to hypothesize that a similar design approach was needed for online learning. Now three years after first launching our online courses, with online results as strong as those of our in-person courses, we are confident that this design makes a difference. The many students who desire or are dependent on online options to meet their education goals deserve a learning experience just as rich as one that an in-person course would provide, and one in which they see value and purpose in what they are learning and that supports their success. Facilitating such an experience means intentionally creating a productive and supportive collaborative learning environment in the online space.



¹Jaggars, S. S., Edgecombe, N., & Stacey, G. W. (2013). *What we know about online course outcomes*. [Research Overview.] Community College Research Center, Teachers College, Columbia University.

Designing for an engaging online learning experience

In educational research and practice, across disciplines, and from elementary to post-secondary education, much attention has been given to promoting collaborative learning in in-person classrooms. Now, because of increasing interest in and need for online learning — most dramatically during the COVID-19 pandemic — we seek to bring the same focus to collaborative learning online.

Collaborative learning is an educational approach in which groups of students work together in learning activities such as problem-solving, projects, and the discussion of concepts and ideas. These kinds of active, engaging experiences can yield many benefits to students, including

- deeper and more robust learning;
- higher-level thinking and stronger communication and leadership skills;
- greater self-efficacy, participation, and retention;
- exposure to and an understanding of diverse perspectives; and
- better preparation for social and workplace interactions.

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Our approach to collaborative learning

Student collaboration is a central element of the Carnegie Math Pathways instructional design. The design consists of four key pillars:

Active instruction

The courses are delivered using a discovery-based, collaborative learning approach that supports student reasoning, discourse, and engagement and promotes social belonging.

Relevant, authentic curriculum

Course curricula are centered around rich and relevant tasks that promote engagement.

Math content supports

Scaffolded supports are built in throughout to support the college content.

Productive Persistence

Social emotional supports are embedded to foster a growth mindset, self-efficacy, and a sense of belonging.

These instructional design pillars are critical to the success of our face-to-face courses and have been carefully adapted for the virtual space.

To guide us in translating these ideas to the online space, we followed an overarching framework developed using expert practitioner input and informed by research in our course design and development. This framework outlines a comprehensive set of core principles we believe create a successful online learning experience by addressing the needs of learners and avoiding the pitfalls of traditional online course models. Engaging students in collaboration is central to this framework.

Pathways Online Design Principles

Always welcoming

Feel like you belong, right from the start

Coherent

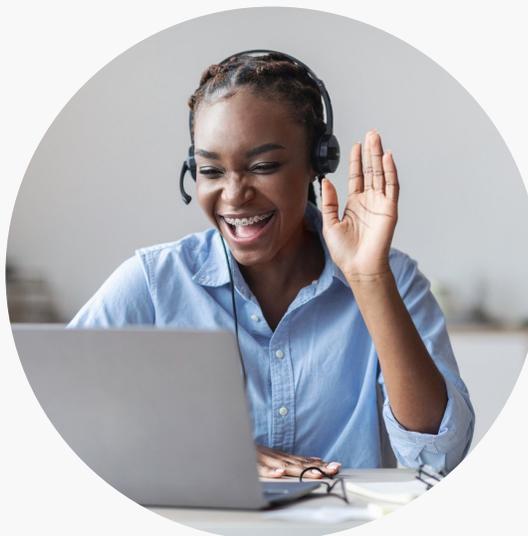
How everything fits together is clear

Adaptive

The learning system meets you where you are

Collaborative

You teach others and learn from them



Supportive

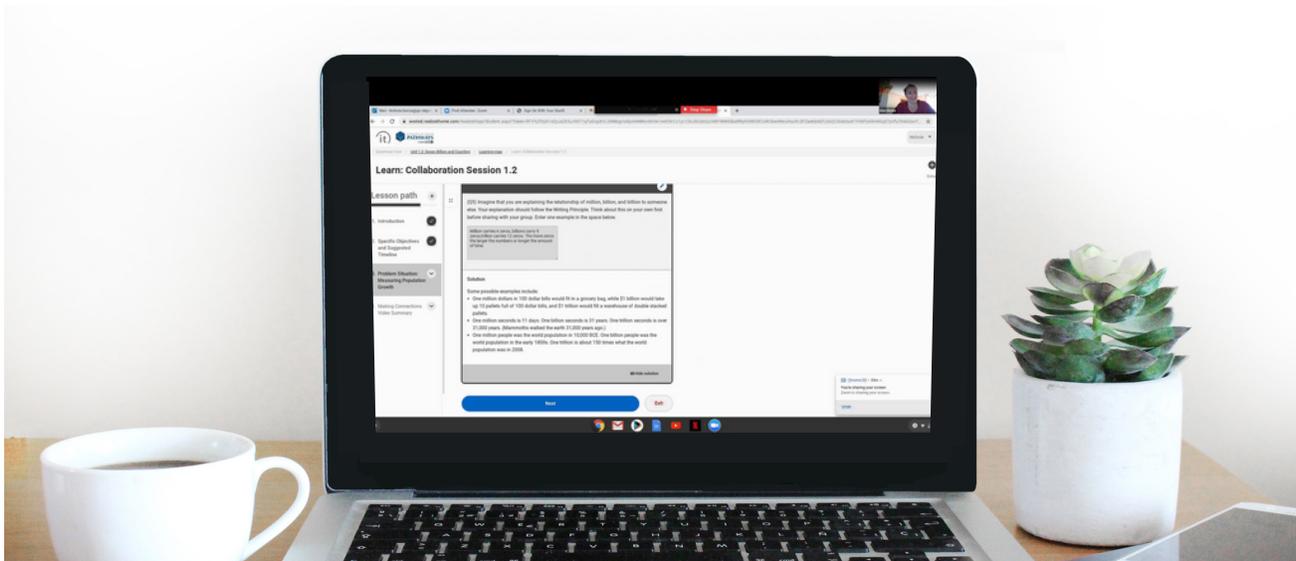
Help is there when you need it

Interactive

Communication is rich, meaningful, and productive

Intentional

A controlled structure and flow always provides an explicit next step



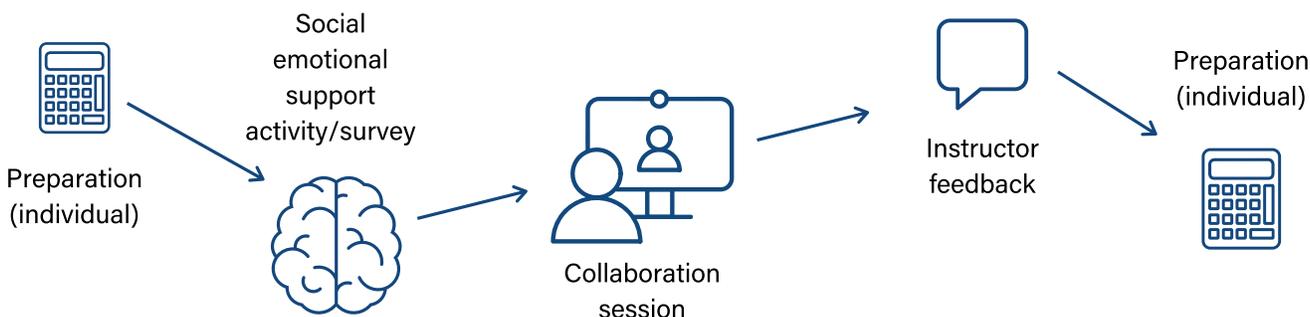
Operationalizing collaboration and connection in online learning

Each Carnegie Math Pathways course unit is centered around a collaboration session in which students meet together in small groups. Prior to and after this session, students prepare individually and complete a follow-on assignment in order to build the prerequisite knowledge and context needed for the session and then to deepen and extend what they learned in the session.

The collaboration sessions are typically an hour long, held twice a week, and are completed without the presence of the instructor. This provides flexibility so the groups can meet when they are able and the instructor is not overscheduled. To support students' ability to work through each lesson on their own productively, the content of the tasks is enhanced with additional scaffolding, prompts, and hints.

At the end of each collaboration session, students record a synopsis of their work together, which is made available to the instructor. The instructor views the summary of the session, along with group responses to the lessons, and provides feedback on the successes, challenges, and misconceptions.

Pathways Online Learning Cycle



Outcomes and learnings

Early results show that this design is having positive effects. Course outcomes from fall 2019 through spring 2021 show that students enrolled in Carnegie Math Pathways online courses have similar or higher success rates as students enrolled in Pathways in-person courses do, even as implementation scaled dramatically in fall 2020. And students and faculty are reporting that the collaboration component in particular is an important and meaningful part of the learning and teaching experience.

These courses have demonstrated that authentic collaboration and connection in online learning is possible and that it has benefits for both students and instructors. Here's what we've learned about the conditions and design elements that contribute most to productive collaboration and how that collaboration impacts the student and instructor experience.

Benefits of Designing for Productive Online Collaboration

Students

- **Demonstrate agency and ownership** of the learning process and understanding
- **Build strong bonds** with peers
- **Value group work** and learn how to productively engage in collaboration

Instructors

- **Gain deeper insight** into student thinking
- **Have access to multiple student group artifacts** that represent thinking and understanding
- **Experience shift in mindsets** about student capabilities



Embedded collaboration tools and well-structured content and tasks enable productive collaboration that leads to student ownership of the learning process.

Students in online Carnegie Math Pathways courses are engaging in the bulk of their learning through synchronous, group-based, and unsupervised interaction and activity. Doing so gives students valuable opportunities to exercise agency and ownership of their learning process and their understanding, a key benefit of collaborative learning. Yet facilitating this type of learning online requires careful design.

Productive engagement among students in Pathways online courses is possible in large part because collaboration is not just an expectation of the course. Rather, it is supported through collaboration tools that are seamlessly integrated within the learning platform, making collaboration easily attainable for students and a natural element of the learning experience. Carnegie Math Pathways' courseware includes embedded Zoom video conferencing so that students can readily engage in group work directly within their learning platform. Additionally, group work is centered around rich problem scenarios that engage students in a variety of tasks that necessitate self-direction, including conceptual tasks that require discussion.

Norm-setting and routines help build a collaborative class culture that nurtures inclusivity and connection among students.

A sense of belonging and connection with peers and the instructor has been shown to impact students' persistence and course completion.² In Pathways online courses, collaboration is used to help build connection from the very start of the course through early norm-setting activities and reflective prompts and routines throughout the course.

Beginning with an introductory module that includes reading and discussion, students explore the benefits and challenges of group work and consider what group members can do to make their collaboration productive. Then, together, they work through an activity to create a "group resume" that showcases the experiences, knowledge, and achievements of the group. This serves to promote connections within the group.

In addition to early norm-setting that establishes the tone and cadence for collaboration, students need opportunities to reflect on the group learning process. This reflection helps students think more critically about the experience and gain a deeper appreciation for working with their peers. It also helps them improve how they work together.

Students in Pathways online courses respond to prompts for reflection before and after each collaboration session. These reflections enable them to evaluate their group learning experience and help them build group identity. Part of the Pathways reflections also includes peer-noticing routines to help group members look out for and support group members who disengage or are absent, thus affirming and nurturing community in the course.

² Walton, G. M., & Brady, S. T. (2017). The many questions of belonging. In A. J. Elliot, C. S. Dweck, & D. S. Yeager (Eds.), *Handbook of competence and motivation: Theory and application* (2nd ed., pp. 272–293). Guilford Press; Walton, G. M., & Cohen, G. L. (2011). A brief social-belonging intervention improves academic and health outcomes of minority students. *Science*, 331 (6023), 1447–1451. <https://doi.org/10.1126/science.1198364>; Walton, G. M., & Cohen, G. L. (2007). A question of belonging: Race, social fit, and achievement. *Journal of Personality and Social Psychology*, 92(1), 82–96. <https://doi.org/10.1037/0022-3514.92.1.82>

Structures that promote accountability and equal participation help students come to value group work and engage in collaboration productively.

Alongside norm-setting and reflection, accountability structures that encourage the equal participation of all group members enhance group inclusivity and functionality and impact students' perceived value of collaborative work. We've found that in online courses, stable groupings that remain in place throughout the full term are particularly valuable to students. In these groups, the use and regular rotation of roles (e.g. "leader"/recorder, facilitator, progress monitor) provides supported entry points for students to engage and helps build each student's capacity to collaborate productively. Each role represents a different and critical aspect of working in a group, and, no matter which role a student is in, they are expected to contribute equally.

In addition, we've given online students a group collaboration rubric so they can engage in peer evaluation of the quality of participation. This, along with instructor feedback and, in some cases, required group engagement in order to earn the course participation grade, helps reinforce the value placed on collaboration as a meaningful aspect of the course.

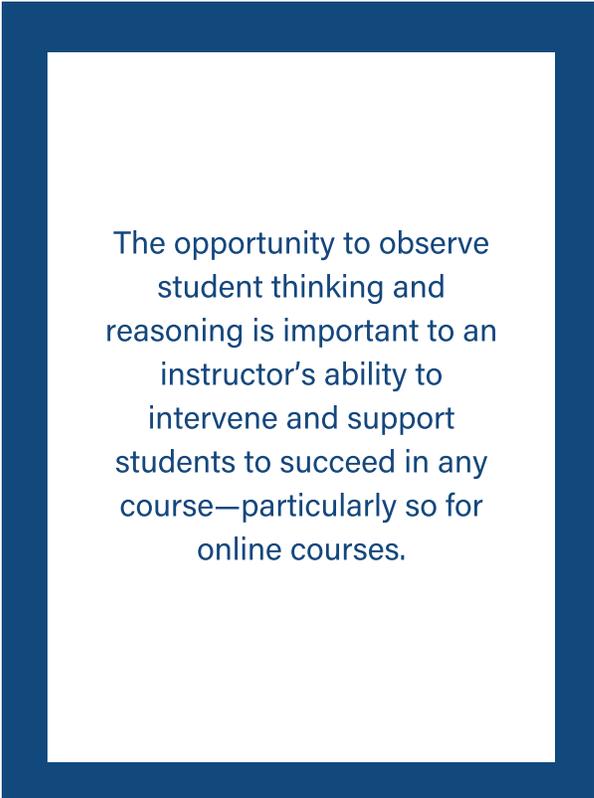
Collaborative learning that is visible to the instructor in the online space provides deeper insight into student thinking and the improved ability to support learning.

The opportunity to observe student thinking and reasoning is important to an instructor's ability to intervene and support student success in any course — particularly so for online courses. In Pathways online implementation, instructors have access to multiple sources of information, including the recorded synopses created by student groups that detail their collaboration sessions, responses from the group work, and individual student reflections. These sources offer a window into students' thinking, engagement, and understanding, enabling the instructor to respond meaningfully and provide helpful feedback.

Group dynamics are also visible to instructors. For example, the early group-work module and resume activity provide the instructor with insight about the individual group members, and the peer evaluations and reflection prompts provide information about what groups need in order to be productive and successful. With this knowledge, instructors are more informed and better able to provide targeted support to students when and where it is needed.

Productive online collaboration leads to a shift in instructor mindsets regarding the capabilities of students.

Additionally, instructors of the Pathways online courses reported a shift in their own mindsets about student capabilities, realizing that students are often more capable of learning and problem-solving together, on their own, than instructors previously thought. With a richly engaging curriculum that is structured to guide and support students through each lesson and to provide an easy way to collaborate with their peers, Pathways students demonstrated their ability to take responsibility for their learning.



The opportunity to observe student thinking and reasoning is important to an instructor's ability to intervene and support students to succeed in any course—particularly so for online courses.

Recommendations for supporting productive collaboration online

Set norms early to build community and a practice of productive collaboration in an online class.

Fostering community and collaboration effectively requires

- creating an explicit definition of productive collaborative learning;
- motivating student participation by making collaboration part of the course expectations, making it count toward students' grade, and messaging to students that most of the course learning takes place in collaborative groups;
- providing opportunities for students to reflect on what works, what is challenging, and what they can do to be good collaborators; and
- offering students opportunities to practice or model good collaboration through activities that help them identify and try out effective group practices while building community.

Ensure collaboration is easily attainable.

Reducing barriers to entry for student online collaboration requires

- intentionally designing to reduce obstacles and increase flexible access to synchronous learning sessions; and
- integrating tools to support synchronous sessions within the learning platform, thus making collaboration part and parcel of the online learning experience.

Design content to promote reasoning and discussion.

To best support productive collaborative learning, content should be designed to

- engage students in conceptual rather than skills-based tasks in order to promote discussion and discovery;

- include group-worthy tasks that promote students bringing together their individual knowledge and working collectively to problem-solve; and
- engage students with projects that involve multiple and varying tasks and opportunities for self-direction.

Create opportunities for ongoing reflection in order to help improve the quality of collaboration and change students' minds about group work.

Reflection activities are most impactful when they:

- engage students immediately after a collaboration session;
- include individual and group activities;
- are brief and more frequent at the term's start, tapering off later in the term; and
- are intentionally designed to promote and support social ties among group members.

Put in place group accountability structures that encourage equal participation, and scaffold development of the students' capacity to collaborate productively.

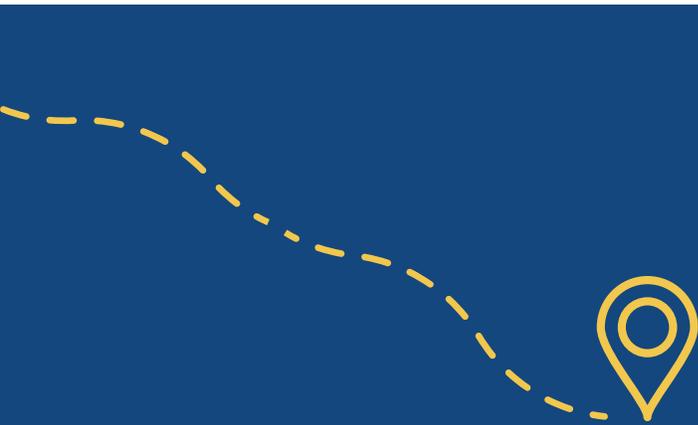
Roles and structures that can be most impactful are

- titled roles with discrete responsibilities, such as "leader"/recorder, facilitator, and progress monitor;
- role rotation in each session;
- peer evaluations of quality of participation, using a group collaboration rubric;
- opportunities for feedback from the instructor; and
- including collaboration sessions as part of a course participation grade.

What we continue to learn

The success of the online Carnegie Math Pathways course options has demonstrated the importance of practices that ensure effective collaboration. Yet opportunities for further improving the learning experience remain. We are continuing to investigate effective practices for setting student expectations prior to the start of the course and for structuring and supporting more equitable participation within groups. We are also navigating the challenges of secure assessment and exploring greater use of project-based assessment online.

The outcomes to date show that with thoughtful design and planning, we can create online learning experiences that are as rigorous and engaging as in-class experiences. By making meaningful student engagement central to any online course, we are transforming the online learning experience to be inclusive, supportive, and successful so that students seeking their education online can enjoy the same effective and engaging experience that they would have had in person — but with all the benefits of flexibility that online learning provides.





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