Public Libraries Engage Families in STEM

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Although emerging research points to the strong influence of families on children's growth and development, a focus on joint parent and child STEM learning is still nascent. This brief examines how public libraries, with federal and state support, are creating STEM learning that brings together children and families across the K–12 years. It builds on Global Family Research Project's previous policy report, *Leading Family Engagement in Early Learning: The Role of State Library Administrative Agencies.*[1]

Family engagement is a shared responsibility of family members to contribute to children's learning and development, and of schools and communities to ensure families have the tools they need to support their children's success in and out of school. Families guide and teach their children, but they also learn with them. Family engagement encompasses co-learning and the positive relationships that occur when all family members explore new ideas, tinker, and make—especially when it involves STEM and STEAM activities. This engagement also includes leadership and advocacy, as when families press for high-quality STEM teaching.

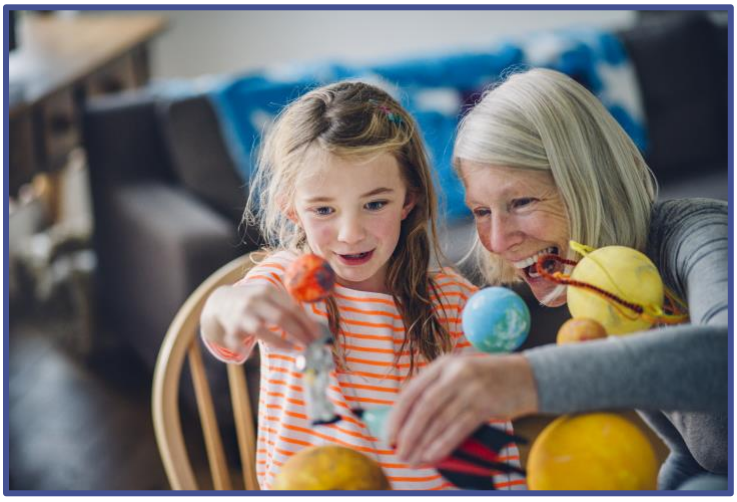
Why families matter in STEM

The STEM subject areas of science, technology, engineering, and math provide powerful opportunities for families to engage in hands-on learning together. When the arts are added, STEAM-focused programs and activities create even more ways for children to express their knowledge and understand complex topics. STEM learning also creates opportunities for students to develop social-emotional competencies and "soft skills," such as the ability to communicate and collaborate.

Schools have greatly expanded STEM instruction, during the school day and in afterschool programs, and now have opportunities under the Every Student Succeeds Act to blend more of the arts into academics as part of a "well-rounded education." But on their own, schools are unable to meet every need for family-oriented STEM learning and exploration.

This family orientation is critical, because parents convey the importance of STEM and motivate their children's interest in careers in the sciences.[2] Lance Liotta, co-director of George Mason University's Center for Applied Proteomics and Molecular Medicine, says, "We were surprised to learn that the family is more important than we ever thought in terms of igniting the passion of future scientists."[3] A study he co-authored showed that childhood experiences with science, and relatives or friends who introduced the children to STEM, were the strongest factors that sparked high school and undergraduate students' initial interest in the field.[4]

When families hold positive mindsets for children's STEM learning and actively engage with students around STEM at home and in the community—from the early years through young adulthood—their children are more likely to succeed in STEM.[5]



A study published in the *Proceedings of the National Academy of Sciences* reports that in a randomized controlled trial, high school students increased mathematics and science ACT scores and course taking when their parents participated in an intervention that provided them suggestions to communicate the importance of STEM education. The students' high school preparation, in turn, was associated with increased STEM career pursuit. Importantly, the parental intervention also correlated with lowering the SES gap in mathematics and science test scores.[6]

Leveraging the power of families to promote STEM learning and careers is a worthwhile investment. Families hunger for information about how to facilitate science learning, even when their children are not yet in school. As many as seven out of 10 parents say that knowing what young children need to learn about science and having ideas for engaging in science with everyday materials would help them do a lot more in this area.[7] And parents of high school students benefit when information they receive can help them convey the value and personal relevance of math and science to their teens.[8]

Public libraries expand opportunities for family-oriented STEM.

With shortages of math and science teachers in most states, schools struggle to close persistent achievement gaps that exist by race, ethnicity, and gender in STEM subject areas. STEM education disparities are of national concern, because without a diverse and robust STEM workforce, the United States will be unable to meet the demands of our increasingly technology-driven economy, ensure national security, and maintain our global competitiveness in scientific research and innovation.[9]

Public libraries have become invaluable partners in offering programs and spaces that engage children and their family members, and they fill opportunity gaps in subject areas that are important for students' personal success in school and beyond. The U.S. Department of Education's *STEM 2026* report includes libraries as one part of an "engaged and networked" community of practice, where "mentors encourage students to learn about the world around them."[10] When libraries support students' learning in STEM and connect them to STEM career pathways, they also help to meet future workforce demands. As industries continue to evolve and move toward automation, they require employees to have both technical knowledge and expertise as well as the "soft" skills of communication, collaboration, and critical thinking.

Given the crucial roles of both families and public libraries, Global Family Research Project (GFRP) examines how libraries design and implement family-oriented STEM. Although documentation about STEM is widespread, less is known about family engagement in STEM and how public policies can be a valuable resource for innovation in this area. This brief analyzes how six state library systems, and the local libraries they support, are tapping into federal funds and initiatives to participate in an ecology of STEM learning—one in which public libraries complement the work of, as well collaborate with, schools, parks and recreation resources, health centers, and other entities to promote STEM learning. This documentation is part of a larger ongoing project that examines the ways public libraries are engaging families in children's learning from birth to young adulthood.

We conducted key informant interviews with state library leaders in Georgia, Maryland, Massachusetts, Pennsylvania, Washington, and Wisconsin. Based on these interviews with leaders, documentary research, and submissions to GFRP's Living IDEABOOK, this brief demonstrates the innovative and intentional ways that public libraries:

- Make STEM more equitable for children and families
- Engage parents and children in STEM learning together
- Connect school and out-of-school learning
- Create an avenue for youth voice and leadership

Several patterns emerge from the six states about how policies and programs make family-oriented STEM in public libraries feasible:

- State library systems tap into funds from the Institute of Museum and Library Services (IMLS), an independent federal agency, to provide local libraries with grants to implement STEM-related family engagement services.
- State library systems serve as a bridge to innovation as they award federal funds to local public libraries.
- State and local public libraries participate in federal initiatives to promote STEM, specifically the STAR Library Network (STAR Net), a program supported by the National Science Foundation, IMLS, and NASA.
- Federal leadership provides a springboard for statewide adaptation of ideas and practices supported by private and public funding sources.

These patterns are illustrated in the examples below of how public libraries are working to increase family-oriented STEM learning opportunities.

Public libraries make STEM resources more equitable for children and families.

Research shows that as income inequality grows, the most affluent parents are spending more and more on their children's education, further contributing to what are often called "opportunity gaps" between children from lower-income families and those whose parents spend resources on camps, tutoring, sports, lessons, travel, and other experiences that shape their children's futures.[11]

In their book *Restoring Opportunity: The Crisis of Inequality and the Challenge for American Education*, Greg J. Duncan of the University of California, Irvine, and Richard J. Murnane of Harvard University write how targeted interventions can fill some of these gaps and improve outcomes for students. Libraries' work in STEM—through maker spaces, science exhibitions, and other family-focused events—is part of this effort to increase families' access to learning opportunities.[12]

Washington State Library: Bridging Geographical Divides

Recognizing that geography contributes to disparities in STEM learning, states are taking steps to level the playing field. The Washington State Library circulates STEM and STEAM kits throughout rural libraries in the state. The kits include materials that the local libraries can't afford to purchase themselves, such as Lego Mindstorms kits and Cubelets programmable robots. Library branches use the kits to organize STEM-related family events.

"People are very interested in getting STEM experiences for their kids," says Carolyn Petersen, the assistant program manager for library development. The libraries have added materials designed to interest girls in order to attract a more balanced group. Petersen is also working with the Foss Waterway Seaport in Tacoma to obtain the skeleton of a seal for a circulating STEM kit. Working from a template, children and families would learn how to assemble a seal spine on their own.

Penn State: Bringing STEM Experiences to Rural Families

Most museums and science centers are located in urban sites, making it difficult for families in rural areas to experience some of the interactive exhibits and experiences available to those in more populated areas. But with a $588,890 IMLS grant, the STEM Pillars project at Pennsylvania State University brought family-oriented, hands-on learning experiences to families in the Appalachian region of the state. Created in partnership with Discovery Space of Central Pennsylvania and Shaver's Creek Environmental Center, the workshops featured experts working with families at public libraries, covering topics ranging from how meteorologists observe and predict the weather to how scientists protect water quality. "We would definitely do it again, since our patron response was so enthusiastic," says Paula Bannon, the head of children's services for the Schlow Centre Region Library, one of the sites that hosted the workshops.

The sessions accommodated eight to 10 families and were intended for those with children ages 6 to 10. "We want to help both parent and child have a common experience so that they can then talk about it when they see a news article or read something on the Internet," Heather Toomey

Zimmerman, an associate professor of education and the principal investigator for the project, said in a Penn State College of Education article. She added that she hoped the project would also inform researchers about how to better design learning opportunities for families in rural areas. "Forty-two percent of the people who live in this area are rural, and there's a great need in rural Appalachia to develop materials to support learning outside the school in small, community-based organizations."[13]

STAR Net: Creating a National Platform to Make STEM Equitable

STAR Net, a project of the Space Science Institute's (SSI) National Center for Interactive Learning, funded by the National Science Foundation, IMLS, and NASA, is a catalyst for public libraries to reach underserved children and families through exciting hands-on STEM activities. The project supports large and small STEM-related exhibitions, a clearinghouse of STEM activities, professional development for library staff members, and other resources. STAR Net now includes more than 7,500 members; its programs have been hosted by libraries in almost every state; and training for librarians often focuses on how to reach out and engage underserved families.

An evaluation of STAR Net reported that the exhibits supported intergenerational learning. Librarians observed that parents, children, and even grandparents were frequently learning together.[14] Librarians also cultivated parental interest through their actions. As one librarian commented in the evaluation report, "I think people are realizing more that they can influence their child's opinion about math and science learning, and I think we can find ways to aid that ... We make it interesting and model that for parents in our programs and provide them with resources in our collection."[15]

When STAR Net was looking for libraries to participate in its NASA@My Library program during the 2017 total solar eclipse, for example, it targeted libraries serving populations not often represented in science-related fields, according to Keliann LaConte, SSI's professional development manager, in an article appearing in the *Polk County Itemizer-Observer* in Oregon. "There are some gaps [in STEM] as far as Latinos, African Americans, American Indians, Alaska natives, Pacific Islanders, the economically disadvantaged, and women and girls," she said. "We want to make sure those who are in communities without a science center have access to these kinds of opportunities."[16]

Public libraries engage parents and children in STEM learning together.

When children engage in STEM and STEAM activities with their parents or other family members, everyone benefits. In a Futurelab survey conducted in the United Kingdom, for instance, parents said learning in families ranged from helping with homework to teaching practical skills, such as cooking and fixing a bicycle. "The benefits of learning in families were also broad: while supporting children's attainment at school was seen as an important benefit, further perceived benefits of family learning for families included the family becoming stronger and closer and, for children, allowing children to be happy, healthy individuals," the author of the survey wrote.[17]

STEM learning in libraries provides children with opportunities to interact with parents, grandparents, or older and younger siblings that aren't possible in a typical classroom at school. This less-structured environment leads to rich conversations, allows children and youth to see their family members from a different perspective, and enables parents to model their own persistence with a task or project. In taking time for such learning, caregivers show the value of STEM.

These informal learning opportunities also give children and youth ways to direct their own learning and to demonstrate to their parents their areas of interest—as opposed to the often-unanswered question, "What did you do in school today?" Parents, meanwhile, gain a glimpse into new technologies and curriculum-related topics.

Maryland State Library: Supporting Dynamic Spaces for STEM Learning

In 2015, the National Science Foundation supported a pivotal conference, co-convened by Paul Dusenbery of the Space Science Institute's National Center for Interactive Learning and Keliann LaConte, then of the Lunar and Planetary Institute. Titled Public Libraries and STEM, the conference emphasized the critical role that libraries play in creating what researchers have called the "dynamic interactions" in which STEM learning takes place. That conference provided inspiration for organizations such as the Maryland STEM Festival to create opportunities for this type of dynamic interaction in which children and their family members gain knowledge and skills in STEM.

From the beginning in 2015, festival organizers reached out to public libraries to promote the first festival and host events. Because libraries offer STEM-related programming on a regular basis for all ages, they quickly became the most active partner, hosting the largest percentage of events statewide. In 2016, the festival entered into a formal agreement with the Maryland Association of Public Library Administrators to develop a framework for planning, coordination, and promotion of the festival. Libraries and families now benefit through collaboration with STEM providers, such as interacting with NASA Goddard Space Flight Center scientists to learn about missions in space, hearing about the latest in cybersecurity from the National Security Agency and LifeJourney, and exploring STEM efforts related to the agricultural and natural science issues along Maryland's Eastern Shore from the Oyster Recovery Partnership.

The festival has grown to include more than 50,000 participants of all ages, with many programs involving math, science, and other STEM subject areas taking place in schools and other community locations during the two-week event period in the fall. Through a partnership between the Maryland State Library and festival leaders, local libraries allow families to participate in the learning and celebration by serving as display sites for the festival's art contest. Additional themes for the STEM activities include astronomy, agriculture, and STEM in military careers. "There's just a lot of cheering among families at these events," says Carrie Sanders, the youth services coordinator for the

state library. "Families are laughing and growing in ways they don't necessarily explore at home on their own. These STEM programs involve children of different ages working together: whether it is a teen volunteering to help at a program for younger children or families with children of all ages, this intergenerational and intermingling of ages working together is wonderful to see."

Massachusetts Board of Library Commissioners: Inspiring Bright Ideas

As part of a new grant program supported by IMLS, the Massachusetts Board of Library Commissioners invites local libraries to create maker spaces called IdeaLabs. These spaces provide youth and adults a place to work or collaborate with others on projects, learn how to use equipment such as a 3-D printer, or try out video production equipment.

The Peabody Institute Library's Creativity Lab, in Peabody, Massachusetts, for example, attracts families with middle and high school students. Because the library also participates in the U.S. Department of Agriculture's summer lunch program, which is called Summer Eats in Massachusetts, the lab has also been able to bring its STEM- and art-focused activities to teens participating in the meal program. This past summer, the lab offered a week of robot making, a week of board-game creation, and two weeks of comic-book creation.

Georgia Public Library Service: Making Libraries STEAM-Focused with Mini-Grants

A study appearing in the *Journal for Learning Through the Arts* showed that STEAM instruction led by a highly trained educator can result in increases in science scores for students attending high-poverty elementary schools. District science assessment scores for children in third through fifth grade who participated in nine one-hour periods of STEAM programming focused on the visual and performing arts climbed from the 50th to the 63rd percentile.[18]

An initiative in Georgia provides one example of how libraries are creating STEAM learning experiences for students. The Georgia Public Library Service has used IMLS funds to award mini-grants to libraries for expanding STEM to STEAM-related programs. Fifty-one library systems received the grants in 2016–17. Libraries have used the funds to put together STEAM-focused materials or updated their science-book collections so that families can do more in-home science learning. They have bought Lego Connect or robotics kits and planned programs related to the materials, which attract fathers and young boys. The Marshes of Glynn Libraries, a system along the Georgia coast, also used the STEM funds to hire a professor from the local college to run a robotics camp. This hands-on learning draws families who would not necessarily come to the library.[19]

Public libraries connect school and out-of-school learning.

Children don't just learn when they're sitting at a desk in a classroom. In fact, increasingly researchers have found that the knowledge and skills many students acquire outside of school—at home, in afterschool programs, and as part of various informal learning experiences—are what widen that opportunity gap between children in poverty and those from more affluent homes.

"The undeniable fact of life in America, indeed the world, is that higher-income families are fortunate to have the resources to supplement their children's education with arts, science, history, and engaging, expansive learning," Prudence Carter and Kevin Welner wrote in a 2013 op-ed about their book *Closing the Opportunity Gap: What America Must Do to Give Every Child an Even Chance. "*Children in lower-income families are usually denied such opportunities. And as their schools become more test-focused, they have few places to turn for this sort of vital enrichment."[20]

Libraries are part of a STEM learning ecology that connects many community resources where children and families can participate in the contexts, interactions, and experiences that promote learning and development.

Libraries have become among the places where families can give their children ways to practice and extend what they're learning in school. And when libraries, schools, and afterschool programs work together, those connections to the curriculum are tighter, contribute to stronger performance for students in school, and give parents more ways to support their children's learning while maintaining an element of fun.

Pennsylvania's Bureau of Library Development: Bringing Meaning to Math Content

When Susan Pannebaker, youth services advisor for the Pennsylvania Department of Education's Bureau of Library Development, talks with children's librarians across the state, one message is clear—while they have a lot of programs geared toward families with preschoolers, they often feel that they don't know what to do with families who have school-age children. "More of the librarians are saying, 'We really need to keep the families,'" Pannebaker says. Data from the state's kindergarten inventory also show that students are lacking early math skills that they'll need in elementary school. In response to those needs, Pannebaker is using part of a $900,000 IMLS family engagement grant to work with a retired third-grade teacher—who happens to love math—on a math series for families with children in the primary grades. The activities will be aligned to the state math standards, and it is hoped they will answer for children and their parents why certain skills, such as measurement, will be important for children's futures. The families will also receive some math materials to take home. "If children see their parents thinking it's fun, it can help them persist when it gets hard," Pannebaker says, adding that once the program gets going, she plans to design activities for families with children up to fifth grade.

With the rest of the grant, she's working on another way for libraries to complement the learning that happens during the school day. Instead of just doing a Google search to write reports for school, she wants students and their families to become more familiar with vetted resources, such as

full-text periodicals, available at the public library, and to play around with innovative ways to use digital tools to present their information. Parents, and especially some grandparents raising children, might need a librarian's support when students have to create a multimedia project instead of a written report. She's also hoping to get school librarians involved to strengthen relationships between schools and local public libraries. Both of these initiatives, she says, can also benefit public libraries in smaller communities by giving library staff members more experience working with families and familiarizing them with key content goals for students.

Massachusetts Libraries: Connecting Libraries and Schools

Public and school libraries in Massachusetts work together to deliver the Science Is Everywhere program, designed for children in the elementary grades and their families. Massachusetts Libraries launched a two-year innovation grant program to invite libraries to create a model that others could follow. Some local libraries have focused specifically on targeting the programming to lower-income, "blue-collar" families. Combining STEM and STEAM programs (for younger students), there have been over 215 workshops, with more than 4,000 children and families participating specifically in Science Is Everywhere.

Wisconsin Division for Libraries and Technology: Enhancing the Technology Skills of Families

The Wisconsin Division for Libraries and Technology, which is part of the Wisconsin Department of Public Instruction, sponsors a coding and computer programming initiative within public libraries, which is especially helpful for parents who might not understand what their children are learning in school. The library views coding as a type of literacy skill, namely, the ability to apply computational thinking for problem solving and stimulating creativity. It seeks to build awareness that coding is for everyone, parents and children alike.[21] These library learning opportunities have grown more important since the state added academic standards related to computer science.

Georgia Public Library Service: Creating an Ecology of STEM Learning

Through partnerships with other state agencies and community organizations, the Georgia Public Library Service invites families to extend their learning beyond what is available in the library. For example, a family can check out a DVD on animals and then receive a pass for free admission to Zoo Atlanta. "We've really built these opportunities for families to save money and go do things together," says Wendy Cornelisen, assistant state librarian.

In Gwinnett County, Georgia, part of the Atlanta metropolitan area, librarians also used an IMLS grant to create a tower gardening program, inspired by a similar effort in the Bronx, New York.[22] Even though Gwinnett is a generally affluent suburban county, there are still food deserts and a lack of education about proper nutrition and preventing obesity. Librarians focused on these challenges by teaching local youth some gardening basics and holding a "Teen Chopped" competition. The gardens have also been used as part of literacy and art programs, and helped libraries make connections with new community partners.

Public libraries create an avenue for youth voice and leadership.

A 2015 report from the Wallace Foundation and the University of Chicago's Consortium on School Research stated that young people experience success when they are able to "fulfill individual goals and have the agency and competencies to influence the world around them." The researchers also noted that the developmental experiences that prepare children and youth for productive futures take place in a variety of settings, not just at school or home.[23]

> Public libraries are encouraging students to become agents of their own learning by allowing them to take the lead in STEM-focused projects and programs.

As youth develop their interests and learn new technologies, these experiences create opportunities for children and teens to interact with their family members in different ways. They might develop a new awareness of and appreciation for a parent's or grandparent's skills and expertise while also becoming the "teachers" in the areas of digital media or computer science. And parents' relationships change, too, as they grow as mentors who talk about the relevance of STEM to their children's career aspirations and encourage participation in challenging out-of-school activities.

Teen advisory boards, maker clubs, and internships are a few of the ways libraries allow students—especially those who might not feel such opportunities exist for them in school—to take on leadership roles and develop skills that will help them succeed in higher education and careers.

Massachusetts and Wisconsin State Libraries: Encouraging Teens as Mentors

At the Peabody Institute Library's Creativity Lab (in Massachusetts), teens help lead instruction for patrons on programs such as Photoshop, expand on the work they are doing in school, and initiate their own projects. Teen librarian Cate Merlin often displays some of the students' creations, which further reinforces the library as a space where the students are appreciated and can express themselves.

In Wisconsin, the Waupaca Area Public Library is playing a vital role in a rural community in which few resources are available. In partnership with local schools, the library offers a "Teach Your Parent How to Code" night, and the librarians have formed strong relationships with community members and groups that donate technology resources, such as robotics equipment and refurbished iPads.

Conclusion and recommendations

Public libraries have become a powerful vehicle for extending STEM and STEAM learning beyond formal school settings and for creating opportunities that allow children and teens to learn together with the significant adults in their lives. Local libraries are prioritizing family engagement in STEM in new and creative ways, extending services outside of library walls, and giving youth a voice in what they want to learn and do.

Below are ways that federal, state, and local policymakers can support libraries in furthering families' role in their children's STEM learning.

1 ***Support library outreach to underserved children and families.*** Public libraries are found in almost every community in the country. Their knowledgeable staff and rich collections and their trusted standing in the community are valuable assets for STEM programs. As state and federal policies promote STEM learning, public libraries should be recruited and financially supported as innovators and providers of STEM programs.

2 ***Encourage more family engagement in STEM programs.*** Emerging evidence points to the interest that parents have in acquiring more science-related information and the important motivational role families play in sparking interest in careers in the sciences. Programs that provide grants to public libraries can create specific guidelines about family-oriented learning experiences and youth voice and leadership.

3 ***Build capacity for family engagement in public libraries.*** Engaging families in STEM is still relatively new. While there are opportunities for aspiring librarians to develop competencies to work with children, youth, and young adults, there are often very few specializations and courses devoted to developing skills around family and community engagement. This lack of preparation can be met through professional workshops and meetings, communities of practice, technical assistance, and other avenues for learning. Through these learning opportunities, library staff benefit from knowledge and experiences in how to engage families, and about developmentally appropriate and quality STEM teaching methods.

4 ***Provide incentives for collaborations.*** STEM learning requires librarians to build strategic partnerships. Librarians may be experts at connecting children and families to information, but that doesn't mean they have to have expertise in all content areas. Partnerships with educators, industry professionals, researchers, and community organizations not only lead to a broader array of high-quality programs, but also point librarians to underserved families and communities.

5 ***Fund evidence-based projects that rely on research and evaluation partnerships.*** Research and evaluation are indispensable tools for promoting library innovation and high-quality practice in family-oriented STEM. Through partnerships with universities and research organizations, libraries can co-create evaluation efforts by defining issues or questions that researchers can investigate. They can be part of evaluation committees and share their perspectives on the data that researchers collect. Library leaders can also learn about effective practices and the conditions under which researchers operate, and improve and refine their efforts. These partnerships contribute to basic knowledge and also to implementation lessons that can be shared with other libraries and entities that are working on STEM programs.

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Howard County Library System, 2017

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The Global Family Research Project (GFRP) is an independent, entrepreneurial nonprofit organization that supports all families and communities in helping children find success in and out of school. We create a worldwide exchange of ideas to further the understanding and implementation of anywhere, anytime learning for all. Since 1983, our team has provided leadership to promote strategies that build pathways for children's whole development across all learning environments.

https://globalfrp.org

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