Johns Hopkins School of Education
Center for Research and Reform in Education

ALAN J. REID, PHD
STEVE ROSS, PHD

NOVEMBER 2024

FOSS Pathways™ (PK-5)

INSTRUCTIONAL DESIGN REVIEW

FOSS PATHWAYS (PK-5)

INTRODUCTION

The FOSS® (Full Option Science System™) Program is a research-based science curriculum designed to meet the challenge of providing meaningful science education for all students in grades PK-8 in diverse American classrooms. FOSS is developed at The Lawrence as an ongoing research effort dedicated to improving the teaching and learning of science and is guided by advances in the understanding of how people think and learn as well as effective teaching practices. With the initial support of the National Science Foundation in four separate funded projects over a period of twenty years 1988-2008, and continued support from the University of California, Berkeley, and School Specialty, LLC, FOSS has evolved into a science curriculum for all students and their teachers, grades PK-8. The developers continually integrate modern research into the program to release a new edition every 5-7 years, building iteratively on the foundations of earlier editions.

FOSS was created to engage students and teachers with meaningful experiences in the natural and designed worlds. Long before the Next Generation Science Standards were developed, FOSS® was founded based on the idea that science is a discovery-based activity that fosters a constructivist process for producing and applying new knowledge. The best way for students to appreciate the scientific enterprise, learn important science and engineering concepts, and develop the ability to think well, is to actively participate in scientific practices through students' own investigations and analyses. FOSS is built on the assumptions that understanding core scientific knowledge and how science functions is essential for citizenship, that all teachers can teach science, and that all students can learn science.

FOSS Pathways is a phenomena-based hands-on science curriculum that was designed to provide teachers with everything they need to meet standards in the limited time they have allotted to teach science. The curricular design strives to meet its three overarching goals: (1) ***Scientific Literacy***. FOSS promotes equity in the science classroom, providing all students with science experiences that are relevant to students' prior and current everyday experiences. These experiences organized in learning progressions provide a foundation for more complex understanding of core science ideas and prepare students for life in an increasingly complex scientific and technological world. (2) ***Instructional Efficiency***. FOSS provides teachers with a complete, cohesive, flexible, easy to-use science program that incorporates current research on teaching and learning, including student discourse, sense-making and argumentation, writing to learn, reflective thinking, and effective formative assessment practices. FOSS uses tested instructional methodologies, including firsthand-active learning with organisms, materials, and systems; collaborative work groups; multisensory observations; integration of literacy; appropriate use of digital technologies; and connections to students' lives, including outdoor experiences. (3) ***Systemic Reform***. FOSS provides schools and school systems with a program that meets science standards and prepares students by helping them acquire the knowledge and thinking capacity appropriate for world citizenship. The program design provides pedagogical scaffolding and tools to support educational reform efforts on all scales, from incremental and continuous improvement to program reinvention. The integrated use of science notebooks and formative-assessment strategies in FOSS redefines the role of science in a school —the way that teachers engage in science teaching with one another as professionals and with students as learners, and the way that students engage in science learning with the teacher and with one another.

The design review that follows is focused on FOSS Pathways (PK-5) as a tool for providing many services for educators, administrators, and parents. A senior researcher from the CRRE reviewed the platform using a registered guest account, and several materials were provided by program developers, who also provided responses to an instructional design-inspired online questionnaire that investigates its program design framework, content selection, design, and development, evaluation, and material interface. Select criteria from an additional rubric - the Evaluation Rubric for eLearning Tools - also were used to assess the product's functionality, accessibility, technical aspects, and its privacy and data protection.

FOSS PATHWAYS (PK-5)

PROGRAM DESIGN & FRAMEWORK

The program design clearly specifies a systemic Theory of Action (or Logic Model).

FOSS Pathways (PK-5) has established a comprehensive Logic Model that clearly articulates a problem statement, the inputs (resources), outputs (strategies and activities) and outcomes (short- and long-term) that aligns with the program framework and guides its iterative development.

A systematic design process was used to develop, evaluate, and refine materials.

Program developers gathered formative data across multiple, iterative designs of FOSS Pathways. Using insight from primary stakeholders, the program experienced a systematic design process that continues to refine programmatic materials and strategies, according to user feedback.

PROGRAM CONTENT SELECTION & DESIGN

A comprehensive design plan was employed in developing the program.

The instructional design of FOSS is explicit and intentional. FOSS is designed around active investigation that provides engagement with science concepts, science and engineering practices, and crosscutting concepts. Driving those firsthand investigations are instructional procedures that facilitate student sense making, leading to understanding of phenomena and scientific habits of mind. FOSS investigations follow a common blueprint of instructional design strategies to provide consistent, coherent engagement with science concepts in an iterative manner. While there is variability in the implementation of the instructional design depending on the context and content of the science, there also is a general flow of design that begins with active investigation in collaborative groups, obtaining and interpreting information through firsthand investigations in real-world contexts, and reflective contemplation using formative assessment.

FOSS PATHWAYS (PK-5)

The program design addresses specified instructional / curriculum needs.

All drafts/manuscripts of the FOSS Pathways content were reviewed to ensure alignment to the Next Generation Science Standards.

The program design addresses individual learner needs for high achievement.

FOSS Pathways differentiates instruction for learners with different abilities in a variety of ways, and instruction with FOSS allows all students to express their understanding through a variety of modalities. Each student has multiple opportunities to demonstrate their strengths and needs through sense-making discussions, collaborative talk with classmates and their science notebooks as well as assessment items. The traditional science notebook can be a dynamic medium for differentiation, allowing each student to express their own thinking in their own way and is a reference tool for students as they analyze their data and construct knowledge from their experience, and self-assessments (I-Checks) provide more opportunity for differentiation. Further, at the end of each investigation, there is a collection of "Differentiation Opportunities" (interdisciplinary extensions) that are designed to meet the individual needs and interests of students. Additionally, online activities including tutorials and virtual investigations are available that teachers can use to support students who have difficulties with the materials or who have been absent.

The program design embraces multicultural and diverse perspectives.

FOSS recognizes that student achievement is impacted by both the content under study and its complexity, as well as by the treatment (including the exclusion) of people with whom the learner has a personal affinity. The instructional materials include multilanguage learner interventions and explicit connections to students' personal experiences.

The program design is accessible and optimized for various environments.

FOSS meets accessibility standards (W3C and/or WCAG 2.0 standards) and is housed on School Specialty's LMS/platform called ThinkLink. The content also can be integrated with other learning management systems, such as Schoology, Canvas, and Google Classroom. Though the majority of resources require the user to be online, the interactive student eBooks are available offline in the app. Mobile optimization is currently not available.

The program is safe and secure for all users.

FERPA compliance is a set of requirements that institutions must follow to protect student data and ensure privacy. School Specialty's ThinkLink platform is FERPA-compliant. FOSS Pathways users retain ownership of their data, and all data is maintained at the district level, not the individual level. Users also can save, export, and archive their content, performance (results), and/or activity data from the previous year.

PROGRAM EVALUATION

Formative evaluation was used to develop and refine the program.

Program developers regularly seek feedback from stakeholder groups to refine the program. The approach used to develop the original FOSS elementary materials followed a three-phase process that included a (1) Development Phase, (2) Local Trial Phase, and finally, a (3) National Trial Phase. In each phase, stakeholders provided feedback and formative data for program improvement.

Further, FOSS has partnered with several school districts to provide Implementation Science best practices and create sustainable, strategic action plans to guide instruction and focus on data-driven professional learning needs. Districts provide feedback on an ongoing basis to help refine the program, the tools, and practices.

Summative evaluation was used to obtain evidence on program effectiveness.

A summative evaluation is being planned with a third-party evaluator in order to document the effectiveness of FOSS Pathways (PK-5) outcomes.

MATERIALS / INTERFACE DESIGN

Costs and resources needed for using the program are clearly specified.

The FOSS website offers a variety of resources for individuals, schools, and districts. Representatives are available to discuss purchasing orders via a contact form and multiple social media channels. It does not appear there are any hidden costs.

Support for users is timely and effective.

There are a variety of support options available to teachers and administrators implementing the FOSS program, including but not limited to, customized professional learning, technical support, free webinars, an online Administrators Toolbox, and an extensive online Knowledge Base. For technical support, email and phone contacts are readily available and responsive. Further, teachers have the opportunity to collaborate via the FOSS Communities of Practices (online virtual sessions) and via in-person professional learning sessions.

Students receive clear and relevant feedback about their performance

Assessment results related to student progress are provided to teachers and students in the FOSSmap online assessment system. The system provides detailed analysis of student-level data and outputs customized reports, such as the Student by Item Report, Class by Level Report, and Standards Report, to be shared with students and their parents / guardians. FOSSmap also generates Next-Step Strategies that are based on student assessment data and that can be applied to individual learners.

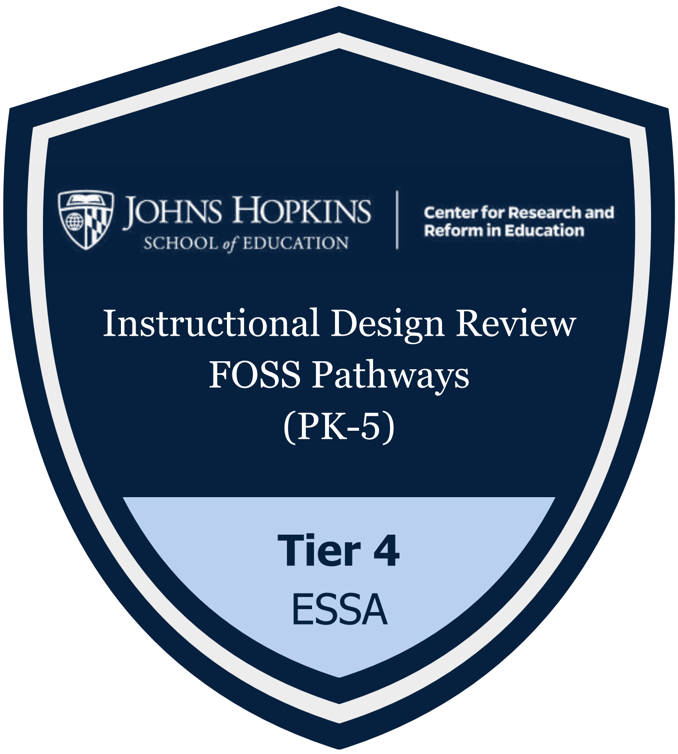
Teachers receive assessment data for tracking students' progress.

Teachers and administrators are able to view assessment data via the FOSSmap online assessment system on ThinkLink. There are a variety of customized reports available--some of which can be exported and shared, such as the Student by Item Report and Administrator Report. Additionally, an API is currently being developed to transfer raw data to district analytic tools (e.g., Power BI and Tableau) for analysis.

FOSS PATHWAYS (PK-5)

ESSA TIERS OF EVIDENCE

According to the Every Student Succeeds Act (ESSA), Tier 4 evidence demonstrates a rationale in the form of a clearly articulated logic model and current or future plans to study the effects of an intervention. A third party evaluation was conducted by senior researchers in the Center for Research and Reform in Education at Johns Hopkins University. Based on this review, it has been determined that FOSS satisfies the criteria for meeting ESSA Tier 4 evidence.



APPENDIX: LOGIC MODEL

RESOURCES (INPUTS)	STRATEGIES & ACTIVITIES (OUTPUTS)	PROGRAM OUTCOMES: SHORT-TERM	PROGRAM OUTCOMES: LONG-TERM
STUDENTS • Phenomena-based hands-on active science curriculum (print and digital-based) • Module-based units of instruction, aligned to NGSS and covering physical, earth, and life sciences and engineering • Materials for student investigations • FOSS Science Resources Book • Resources in English and Spanish	• Sense-making discussions • Collaborative talk with peers • Science notebooks • Benchmark assessment (I-Checks) • Formative assessments • Online activities and multimedia	• Engaged and active learning • Excitement about science • Exposure to diverse role models and scientists • Respect for the natural world • Accessibility to STEM • Productive participation in collaborative discussions with peers • Use of evidence to develop explanations	• Scientific literacy • Growth mindset • Collaboration with peers • Scientific communication (verbal, writing, drawing) • Understanding of the natural and designed world • Development of habits of mind in science • Ability to apply science knowledge to community and societal issues • Ability to evaluate information based on evidence
EDUCATORS • Materials for student investigations • Student resources in English and Spanish • Professional learning opportunities • Administrators' Toolbox • Virtual Communities of Practice • FOSSMap Online Assessment System	• Student-level data and customized reports • Next-step strategies, based on learner data • Accessibility strategies for equity in the classroom • Science-centered language development and literacy resources • Educative instructional materials • Research-based best practices in science pedagogy • Use of outdoor schoolyard and community environments for science investigations	• Instructional efficiency and ease using materials • Facilitation of student engagement in scientific practices • Support for differentiated instruction • Confidence in teaching science and understanding scientific practices and crosscutting concepts • Joy in teaching science	• Systemic reform in science education • Prioritization of science in the district • Development of habits of mind in science • Improvement of understanding of science, scientific practices, and crosscutting concepts • Relevance of science for students