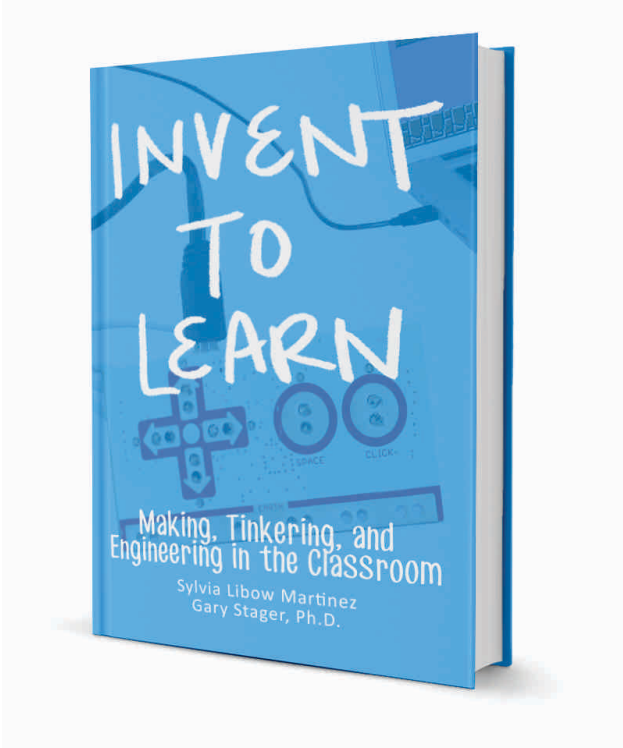
BOOK REVIEW

Invent To Learn:
Making, Tinkering, and Engineering in the Classroom

Authors: Sylvia Libow Martinez, Gary Stager



SUMMARY

Martinez and Stager remind us of the learning, and the joy, that comes when students have the opportunity to tinker and invent. They also provide a comprehensive outline of game-changing technology for schools, still highly relevant today.

In 2013, when Sylvia Libow Martinez and Gary Stager wrote this persuasive rationale for invention in schools, the modern Maker Movement was still being discovered for the first time by teachers around the world. Many of the tools now familiar in classrooms, such as Makey Makey, Scratch and Arduino, were still bursting onto the educational scene. School makerspaces were growing in popularity, and Digital Technologies was just entering the compulsory curriculum.

But Martinez and Stager foresaw a danger: what if the spirit of the Maker Movement gets squashed in the classroom? What if, instead of students learning *by* Making, the education system turns Making into just another thing to learn *about*?

With State and Federal governments talking up STEM and STEAM, Australian schools now required to implement Digital Technologies curriculum from P-10, and teachers pressed into service to instruct students in coding, this danger seems more real than ever.

After a quick history of educational thinkers who valued invention as a way of understanding, *Invent to Learn* defines the three Ways of Knowing in the book's title; Making, Tinkering and Engineering.

With Making, we become DIYers, using the increasing availability of "transformative materials". We've always had wood and ice-cream boxes, but we haven't always had accessible, fun coding environments, 3D printers, or microcontroller boards so easy to program.

With Tinkering, we play and inquire. Problems are approached through iteration and contemplation, not just linear step-by-step problem solving processes.

With Engineering, we design, invent and build based on scientific principles. For all the lip-service given to STEM, what do the majority of teachers think when we hear the word Engineering? Martinez and Stager write:

> *Unfortunately, we think of engineering as being something very serious one studies at college. In fact, engineering is something that is perfectly compatible with young children. When we encourage children to build with sand, blocks, paint, and glue, we are simply asking them to take what they know about science and apply it to the real world. In the truest sense, children are natural engineers and we can create classrooms that celebrate this fact...*
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> *… Engineers plan, but they also experiment and tinker. Yet, most kids are deprived of engineering experiences until they endure 12 years of abstractions. (p. 39)*

Those who have heard Gary Stager at a presentation or workshop will know that he is not afraid to critique pedagogical practices that he believes get in the way of, or are extraneous to, student invention.

The book challenges various notions about thinking, justification for the 'A' in STEAM, and the use of popular design process models with school students. Other models, such as TMI

(Think, Make, Improve) are suggested as ways to give students more agency. Practical advice is given on how to best approach and frame school projects.

The book goes on to outline the "game changers" that have emerged; fabrication (such as 3D printing), physical computing (such as Arduino or Raspberry Pi), and programming (such as the Scratch environment). A comprehensive list of school-friendly tech is defined and described, from wearable electronics to CAD software, to choosing a programming language. Since the book was published we have seen some convergence between these technologies, as well as promising and affordable tech options like the BBC micro:bit, but the "game changers" are still arguably unchanged, regardless of the specific product.

The final chapters offer advice on transforming a school beyond just setting up a makerspace, including fostering student leadership.

DLTV is currently looking back 40 years to the first meeting of the Computer Education Group of Victoria (CEGV). Inspired by pioneers like Seymour Papert, teachers across Victoria were fostering Computational Thinking in the 1970s and 80s, with tools like the Logo language (think of the "pen" in today's Scratch).

Students in 2018 have far more experience as consumers of digital technologies. New, more streamlined electronics and robotics kits are appearing, and digital manufacturing through 3D printing and laser cutting has never been more accessible to schools. But the same challenge remains - will our students have a packaged, theory-driven experience of Digital Technologies, completing pre-set tasks to achieve predefined goals. Or will they find the joy of generations of tinkerers before them as they ask, "I wonder what *this* will do?"

Review by Nathan Alison,
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