Setting Powerful Ideas to Music

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Abstract

Soon after first connecting with the Logo Project at MIT 40-odd years ago, the author joined the ranks of those who sought to expand its original pedagogical vision to embrace the arts. The ideals of Constructionism's founders have continued to inspire his efforts to stimulate musical awareness and support creative imagination by helping children to design their own simple musical compositions. In the course of this work, much was learned about music, about young minds, about computing, and about constructive education.

Initially, his student research team at York built an extensive library of special Logo-based software routines, designed to drive a series of hands-on exercises and projects in computer-assisted musical construction. Successful trials of York's first portable "musical computer" in Ontario schools revealed some basic requirements for an educational environment conducive to creativity. Eventually a commercial software package embodying key ideas from the York project was commissioned for the earliest personal computers.

Seymour Papert's insistence that computers can link abstract thinking with concrete know-how was a major influence on this work. However, the nature of children's mental processes while composing remains as much a mystery as it was before computerized music production became widespread. And a recent survey of available software oriented toward composing for beginners reveals disappointingly little attention to its suitability for young users. Some promising exceptions, as well as recent proposals for a radical reorientation of programming itself, could help to awaken new interest in the potential of digital media to stimulate musical thinking and facilitate its expression.

While the Constructionist vision of computer-mediated, self-directed learning has inspired successful efforts to energize and enliven the teaching of science and mathematics, a preoccupation with the power and glamour of new media resources has sometimes prevented students from developing the skills and acquiring the life experience they need to undertake serious creative work in the arts.

In reviewing some of the chief lessons gleaned from his earlier work, the author, following Papert's injunctions, hopes to contribute to a continuing dialogue about the role of the arts in education, the proper and improper uses of disembodied media, and the various means by which we appropriate and invent new knowledge.

NOTE: This paper will be accompanied by a series of visual projections, amplifying or illustratiing key points.

Keywords

musical composition; constructionism; music pedagogy; educational software;
creativity in children; Logo; artificial musical intelligence; programming languages.

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A. Joining the Movement

1) Border crossings

All of us have been touched, in one way or another, by the same particular current of ideas about computation, constructive learning, and children's minds that was notably espoused by Seymour Papert and others at MIT in the 1970s and 80s. Papert's fascination with how children learn to make sense of the world—how their encounters with physical objects, complex relationships, and external forces can stimulate their intellectual and personal growth—has by now become our own.

Educational dogmas and fashions have come and gone in the years since The Children's Machine and Mindstorms first appeared. Yet people of all backgrounds and specialties, in many countries, still find in these books both an inspiration and a challenge. The 'children's machine' par excellence is, of course, not the computer but each child's own embodied brain. Papert insisted that children need the serious fun of discovering how their world works, by playing with it and constructing complex ideas about it. Has not this same capacity for playful discovery given rise to some of humanity's proudest achievements, in such fields as mathematics, science, or the arts? Yet somehow we seem to have forgotten how to make it flourish for ordinary kids in ordinary classrooms. Perhaps that is why, some forty-odd years later, Papert's powerful ideas can still challenge teachers at all levels and in all fields, mine included, urging us to use new media only in ways that will respect, and join forces with, every child's native genius for learning.

Some years before Papert's work became widely known, I found my way to the AI Lab at MIT, and was encouraged, by Marvin Minsky and others, to join the handful of pioneering experimenters who frequented the room in which its Logo Project was housed. To those of us who lacked a background in electronics or engineering, Logo seemed the perfect entry-point into an exciting new world of futuristic educational machinery — simple enough for our kids (and even us) to master, yet with all the allure and limitless promise of a newly emergent technology. We saw how quickly children were captivated by the activity of writing a simple computer program, then watching as a toy robot carried out their instructions. New pathways to personal knowledge seemed to open, when children could "teach the machine" how to achieve their desired goal step by step, and then actually see, feel, or hear whether it succeeded—or at least figure out why it failed, and correct their program accordingly. And for at least a few of those kids, using Logo to draw geometric shapes, drive toy robots, or generate simple tunes did seem to stimulate and engage them more than school ever had before.

The invitation to speak at CONSTRUCTIONISM 2010 could not have reached me at a better time. I had already begun to look back on my years "in the movement" and the questions we grappled with along the way, some of which still perplex me a generation later. Hence the hopeful title of my presentation, which points to an ongoing process, but promises no pat answers or foolproof solutions. In it, I will try to explain why extending the impact of Logo to include certain kinds of music learning seemed at first not only plausible, but a promising good fit. Eventually, my Logo experience worked just as Papert predicted—that is, it called into question most of my assumptions about composing, computing, self-instruction, creativity, and even about the nature of musical knowledge itself. The rest of my paper focuses on a few of the issues thus raised, and hints at some possible directions for future development.

Music is one subject on which everyone is entitled to their opinions, so I hope you will feel free to complain, disagree, or argue with anything I say, and share questions of your own, whenever and wherever you can find me. After all, isn't that why conferences like this one are still worth attending in person?

2) A voice for the Turtle

As examples of "concrete thinking", the early exercises in turtle geometry still seemed pretty limited and abstract to me. Though one heard talk of encouraging children to "think like a real mathematician", Logo's emergent "Mathland" was evidently far more modest in scope. Geometry had after all been for centuries a preferred zone for the exercise for young minds; so not surprisingly, it was there, rather than in the loftier realms of contemporary higher mathematics, that the Logo turtle found its pedagogical niche. But compared with what usually goes on in a typical math classroom, the Logo style of solving geometry problems by trial-and-error programming must have seemed far more active, more concrete and more engaging.

If any comparable "safe zone" for children's musical problem-solving existed then, one would have been hard put to locate its limits. Under the aegis of the Logo Project, both Jeanne Bamberger and I set out to remedy that lack. (Many of you are no doubt familiar with the remarkable contributions she has since made to constructionist pedagogy as a result.) Though we began with only a meager handful of sound-defining primitives, we did have available a barebones device called the Logo Music Box, of which a couple of samples had been cobbled together by Papert's brother. Its limited repertoire of programmable beeps, pops, and gritches could only be brought into some semblance of audible order by executing programmed instructions written in Logo code.

Looking back, I can see how lucky we were that our robotic music-making capabilities were so limited. Our very low-fi version of "the children's machine" really did sound more like a turtle in heat than anything else, and was devoid of any obvious sonic appeal. Logo's very abstractness, on the other hand, was for some music educators its great attraction as a potential new medium for learning. In music classrooms, the emphasis is often so overwhelmingly on the live activity of producing and combining sounds that there is little or no time to reflect on the structure or design of what is being played. (Much of that will anyway have been pre-composed by various dead white guys—but more on that theme later.)

A further advantage, it turned out, could be gained from using Logo code as a means for expressing musical intentions. To get beyond the note-by-note processing that common music notation seems to demand, and learn to think in the musical equivalent of complete words, clauses, or sentences, can take years, and sometimes never happens, so strong is the unconscious cognitive prejudice imposed by the standard notational graphics in use today. What a relief it was to discover that the power and simplicity of recursive definition in Logo encouraged its users to work mainly with whole musical gestures and even larger spans, instead of those isolated atoms called "notes"!

3) Pioneers on the Logo frontier

I came back to my Canadian university post from MIT in the early Seventies, eager to begin developing computer-assisted methods of musical exploration for Ontario schoolchildren. As a teacher, performer, and former child improviser myself, I had long had a particular interest in helping children create music of their own. I was naturally eager to see whether Logo, though offering only limited access to the twin powers of programmed control and automatic sound generation, could nevertheless help reduce some of the technical obstacles that discourage children's creative play with melodies and rhythms. Would novices start to think a little more "like a composer", I wondered—or even, more like a programmer— if they were able to use the computer as a kind of musical Lego set, first imagining a desired musical gesture or phrase, then

instructing the machine how to realize it step by step, and finally hearing the result played back, if only sketchily, by the digital Music Box?

With the help of a generous government grant, I set up the first Logo development lab in Ontario, staffed with York undergraduates, only one or two of whom were majoring in Computer Science. The sonic output of our robot MusicBox was still painfully crude, and Logo a very clumsy and blunt instrument for musical manipulation, which we could access only via long-distance phone connection from a research center in a distant city. Yet at the time, what we were attempting seemed like a real breakthrough.

Before offering it to kids and their teachers as a music-making vehicle, we greatly extended the Logo language by building a full range of musical pseudo-primitives, as well as new ways of handling and combining list-structures to represent extended sections or whole pieces of music. Then we grappled with how to make this new vocabulary readily accessible to the novice user, trying various shorthand schemes to organize the available choices into a coherent and easily remembered alphabet.

From the outset, we recognized that "real" composing in Logo was way beyond what even the most audacious partisan of artificial intelligence would have dared to attempt. But Logo did give us something almost as valuable: an arena for playing WITH music, enabling kids to build their tunes and other patterns out of nameable, repeatable, transformable, recursively definable entities—motives. phrases, whatever— musical patterns that are less "abstract" but more easily recognized and remembered than mere "notes".

Eventually we ran Canada's first in-school trials of Logo Music, with Ministry of Education support. To be sure, not much extended composing was attempted in those early trials. (Exercises in de-composition predominated.) Both we and the children were feeling our way forward, in what for the cooperating teachers was still uncharted territory.

4) Discovering connections

If Logo was ever to realize its promise as a new approach to music and other arts, or to non-mathematical learning of any kind, let alone as a vehicle for educational reform, an explicit rationale would be needed, but was still lacking in these early days. Those of us with musical interests thus had an extra incentive to work at explaining what it could and couldn't do for us.

To be sure, some kind of involvement in Music-making is known to be encouraged and prized by all human communities (even including MIT professors!). Perhaps this is because making and sharing music can so easily engage both mind and body, by actions the human organism seems expressly designed to perform. Even the littlest children spontaneously use musical sound, speech, rhythm, and gesture in every possible combination to communicate with and respond to others. (One wonders whether Papert ever considered how SINGING develops a child's ability to express ideas with and through the body—without the help of robots or programmable gadgets of any kind.) Adults may also turn to Music to help them achieve emotional expression, cultural rapport, meditative awareness, or social integration.

Besides, Music has a long history of reciprocal involvement with whatever society's latest high-tech advances happened to be. Indeed, few human activities, or even other fine or performing arts, are so strongly linked to multiple cooperating technologies of symbolic communication and physical production. As Jaron Lanier reminds us: "In most historical eras, and in most cultures, we have put as high a priority on creating objects that make new sounds as we have on finding ways to kill one another."

If all this is true, shouldn't the study of music provide ample opportunity for the same kinds of responsive, engaging hands-on transaction Papert sought to introduce into the Math classroom? I imagine some of you are eager to answer: "Of course! But Isn't knowing Music just another mode of knowing Mathematics? After all, we teachers can use musical sounds to illustrate

audibly some simple mathematical relationships, especially for those children who are uncomfortable with numbers." Yes, the spirit of Pythagoras does live on, even here at CONSTRUCTIONISM 2010!

In my view, Music is really more like Language, since it comes in a bewildering variety of different local flavors, traditions, genres and levels—each intelligible mainly to a specific group of users and listeners, yet clearly related to one another and drawing from a common behavioral foundation. To be sure, just as experts in Linguistics have evolved their own special vocabulary and symbology for analyzing what languages have in common, and how individual languages work, so Music Theorists too use words and symbols to explore the workings of musical perception, and to analyze specific pieces or styles. If some would call that a more "mathematical" or "scientific" approach to knowing Music, it's easy to see why. But that is only part of the picture.

The unique constructive role musical training can play in mental functioning and development is now better understood, and has recently claimed the attention of a broader public, thanks to the neurobiological research reported by Sacks, Levitin, and others. A typical Music student begins by learning how to transform the body into an Instrument for the generation and control of sound, with or without the support of specially crafted external objects. Then, one learns how to convert musical data that has been symbolically coded as Notation into a mental image of the sounds and patterns so represented; and finally, how to translate that image into the corresponding physical actions needed to execute an appropriate Performance. More advanced musicians will eventually discover how to commit to Memory an entire composition, line by line and section by section, so that they can in turn teach others how to bring it to life.

Composing requires perhaps the highest level of mental preparation, plus the projective power to imagine whole complexes of structured sound, while awaiting the collaboration of other musicians (or, less satisfyingly, of a well-equipped synthesizer) to hear their effect realized. "Composition," according to Canadian composer Alan Belkin, "is first a matter of craftsmanship— refined use of the materials—and only subsequently enters the domain of art." Yet it is hard to overestimate the degree of bodily, mental, and emotional coordination that a child engaged in even the simplest acts of musical invention must bring to bear. Inventing original music used to be considered too difficult for any but advanced graduate students to attempt. No wonder it gets so little attention in conventional school Music programs, especially when compared to what happens in the visual and graphic arts, where even the youngest kids get to make their own original artworks with their own hands.

Acquiring particular skills and techniques is no doubt important, and there are valuable lessons to be learned in the strategy and tactics of artful construction that can prove applicable in other domains as well. But that could hardly be the whole story. In any case, as the American literacy researchers Pearson and Dole point out, "we have to consider the possibility that all the attention we are asking students to pay to their use of skills and strategies and to their monitoring of these strategies may turn relatively simple and intuitive tasks into introspective nightmares…What really determines the ability to comprehend anything is how much one already knows about the topic."

Not every child will take to Music as a preferred venue for creative work; but those who do will continue to need a wide range of experiential support, beyond what computer exercises alone can provide. Learning too is an art of sorts, as Papert eventually recognized, one for which most children are gifted by nature. Yet in a realm like Music—rather a messier one than Pythagoras once assumed!—they will not proceed very far except by engaging continually with other minds and bodies, other natural and imagined worlds. It's hardly suprising, then, that learning to understand and appreciate Music turns out to be no easier to manage than learning to reason logically or solve math problems; nor should it require any less time or life experience than

learning to enjoy a good book. At least some of that enabling experience, moreover, might well derive from children's own attempts to write, and to compose.

5) Taking the next step

After several years of non-stop discussion, report-writing, conference-going, and action testing, the end result of our early experiments with Logo Music was a new commercial software product, the brainchild of a brilliant former project assistant, Michael Ross, that distilled and repackaged all we had learned. Although not written in Logo or Lisp, this remarkably compact yet versatile program took the original "blocks + procedures" model about as far as it can go. Called TINKERTUNE®, it was produced for the first generation of Atari personal computers in 1986.

As developers, our first job had been deciding how NOT to build a software system to support children's composing exercises. Anything like the prestigious laboratory computer music systems of the day, aimed at advanced and avant-garde composers (e.g. Music5, Cmusic, Max/MSP, etc.), was ruled out from the start, as too demanding of extra-musical attention. Such daunting complexity seemed quite beyond the capacity of most children or their harried teachers to assimilate.

We also ruled out standard notation, which required reading and writing skills too hard for many beginners to master, and was too tricky to program. Without it, our users would have to forfeit membership in the worldwide community of the musically literate, at least for the time being. But we hoped our program would gain in accessibility by using simpler graphic substitutes that were easier to implement on early-model PCs.

The Atari's design made possible a whole new user interface, complete with joystick-controlled cursor, replacing Logo's command-line input method with a simple but effective form of direct selection from a single on-screen menu. That reduced the user's memory load still further, by keeping in constant view the whole range of available operations, as well as all currently available motivic blocks. At the same time, we wanted to reduce or eliminate the need to name and identify everything. Our use of alphabetic keys to both represent and trigger specific musical fragments, keeping the letter P to represent whatever was just Played, for easy rehearing, was a step in this direction.

During the construction process, both bottom-up and top-down views of the work-in-progress needed to be available. An "assembly line" on the main screen offered a simple way to keep track of where each component fitted into the evolving composition. You could then keep referring back to and reusing previously added material as the piece grew—step by step, through trials and retrials, choices and rejections—into a larger and more satisfactory whole.

Though the choices it offered were still limited, TINKERTUNE was a big step forward. Our hope was that this new program could eventually become a springboard for a whole range of tune-building and composing aids, adapted to various styles. But improvements in personal computing hardware came so fast that the Atari platform was obsolete before we could get our package to market. We did however learn some valuable lessons from the attempt.

B. Back to the Future?

About two years ago, I decided it was time to get back in touch with my earlier interest in computers and musical creativity, reconnect with some like-minded teachers, and help them set up children's composing projects in a few of Toronto's public and separate schools. It should be possible by now, I thought, to find all sorts of suitable software packages to buy for this purpose—but if not, we could always sit down and create some of our own, using all the latest user-friendly development tools.

It turned out, of course, that none of this was as easy to accomplish as I imagined. Nor was it likely to happen soon. The software situation looked particularly grim. Though hundreds of different software products claiming to help people make their own music were now available, I found very few developers whose designs took seriously the needs of children, or addressed the job of learning to compose in a way that was neither simplistic nor trivial. In my frustration, I looked for someone to blame. Is it, I wondered, the fault of the Developers, whose ever-more-feature-laden (and ever more expensive) sequencer packages still dominate the music software market, and although clearly meant for use in professional recording studios, are being increasingly sold to schools and foisted on the very young?

Just then, I heard from Wally Feurzeig—a voice from the past, inviting me to contribute to a conference on the future of the movement I joined a generation ago. But will Music be a part of that future? Will the global convergence of today's enormously more powerful digital media ever allow room for our children to be treated as creators, not just as consumers? Let me share three of the lessons we learned from those early experiments, hoping they may help encourage a new generation of constructionist thinkers, teachers, software developers and musicians to join forces and continue where we left off.

Lesson 1: Computers won't automatically reinforce CREATIVITY

Easier isn't always better. Putting into a child's hands a slick and easy way of notating musical ideas and hearing the notes played back instantaneously and automatically, while impressive and fun, doesn't in itself make satisfying music happen. Facility of execution or ease of recording are only beneficial when linked to an active and fertile musical imagination, fed by wide and deep contact with the musical ideas of other composers, past and present. Today's media-savvy children still need what only prolonged, mindful exposure to good teachers, and to a stimulating variety of other people's music, can offer.

Technical advances are a mixed blessing. To work in any way with Music, even as a beginner, one can hardly escape becoming conversant with technologies of various sorts, particularly those connected with symbolic Representation and sound Production. However, Music's very dependence on facilitating technologies can also create more barriers for the novice.

"Composers" don't wear wigs any more. Some would argue that by adapting computers to assist in so many aspects of music-making, the entire discipline of composing is already being reshaped and redefined, at the expense of unique capabilities that humans have learned to exercise over the centuries. Certainly digital sound processing—the manufacturing, manipulating, massaging, and merchandising of "interesting" new timbres and new mixtures of recorded or electronically-generated sounds—fits well with what computers do best. Is that perhaps why so much attention is focused, in the computerized practice of many composers today, on tweaking and refining the quality of each individual timbre or sound-mix, rather than on larger-scale issues of form or expressive content?

No robots need apply! We wanted to build a playground where kids can exercise and develop some of the skills and habits that would make them better able to imagine and shape their own compositions. But our goal was not to make the computer smart enough to do the composing for us. If anything, it was by examining how and why a computer program fails to deliver a musically satisfying result that we hoped to learn more about the creative thinking of human composers.

One thing computers can do well is to support trial-and-error, what-if testing, and unlimited rehearing and revising of what we have already chosen to record. All these are essential parts of the creative process, but were much harder for novices to do before computerized text processing and instantly playable music notation came on the scene. One suspects, though, that the more we involve computers in automating the generation of sound patterns and resolving issues of abstract compositional design, the less we can count on what bodily involvement and

contextual embeddedness have always done to ensure that music retains its powerful expressive appeal.

Lesson 2: Fancy GRAPHICS alone won't save us

Some far-sighted educators, including Papert himself, looked to digital media to free children's learning from the tyranny of Text, which used to be the privileged medium in which all worthwhile knowledge, and the most prestigious creative achievements, must perforce be expressed. This issue is particularly acute for those who work with Music. It's not enough just to get the computer to generate an audible sequence of pleasing sounds. Without the aid of a notated score, a budding composer's effort will leave no trace to work from or refer back to. So we were obliged to invent, and implement, several different kinds of visible support.

Computer graphics has come a long way since those early Atari days. Inventing visually engaging interface designs has become a major preoccupation of software developers. In the twenty-five years since TINKERTUNE was released, a fancy GUI has become obligatory for even the simplest music program. And the variety of designs is mind-boggling. Being able to manipulate playable tokens and experiment with their relative placement on a two-dimensional touch screen, where x = musical time and y = musical pitch, is no small advantage for a beginner. This couldn't be done without the graphic capabilities of a modern personal computer. The skill needed to edit or reorganize recorded sound samples or MIDI tracks, when they are represented visually on a screen, is no longer text-based, and already "concrete" enough to please any good Constructionist. But much more could still be done to integrate visual thinking with musical thinking in the look and feel of software composing utilities.

Visual analogies are not a panacea, however. Especially when it comes to software intended for kids, some of the same problems of function and readability we faced with TINKERTUNE are still around, and deserve special attention. Cross-media "equivalents" that are intended to clarify otherwise invisible relationships or facilitate human-computer interaction need to be handled with particular care and expertise.

Lesson 3: What CHILDREN want is not always what they need

When it comes to creating music, kids want to choose what musical ideas they work with, even if what they like is attuned to what they can share with their peers (especially true for teens). Children are not easily fooled. They know that "Music" equals "Songs," and that Songs are About Something. What initial appeal do abstract Composing exercises have for the average kid? Not much, except perhaps as a game teachers might want to let them play instead of doing regular schoolwork. However, children can be easily led. Many young people now carry their own music player with them everywhere, and have access to an unimaginably vast range of recorded music from which to choose their personal listening fare. If what all those iPods are actually pumping through all those earbuds is in fact nothing but the same commercially driven pop-star hits everyone else is listening to, who is to blame for that?

It's clearly not enough just to let the kids have "their" music, even if we can no longer insist that they be taught to revere "ours". This is where a constructionist pedagogy that includes exercises in Composing may have most to contribute. Without skilled, discriminating, empathetic listeners, the promise of universal musical enlightenment offered by today's convivial digital media turns into nothing more than a sick joke. Imagine a World Cup football match, telecast to every corner of a world in which no one has ever played the game!

At the same time, it is important not to make Composing too quick or too easy. If the process of musical construction becomes too facile, too automatic, or too random, that trivializes the exercise and cheapens the experience. And as Alan Kay has warned: "Media can also lure us into thinking we are creating by design when in fact we are just tinkering."

Our experience supports Kay's conviction that children need and will thrive on truly difficult tasks, as long as the difficulties are not overwhelming. We know that schoolchildren will gladly work hard and long at something as absorbing and fun as constructing their own music. But they must be free to focus full attention on musical materials and musical results, and not forced by the system to fiddle with extraneous details. Provided it is carefully designed and thoughtfully integrated with other approaches, special-purpose computer software can indeed help, by opening vast new possibilities for creative exploration of musical structure at every level. At least then, whatever smarts may ultimately accrue are more likely to be the child's, not the computer's.

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