A Study on the Influence of Technology Hands-on Curriculum on the Technology Attitude and Programming Attitude in Senior High School

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Abstract
The study was aimed to explore the influence of technology hands-on curriculum on the technology attitude and programming attitude. The study sample consisted of forty two 16-year-old students from one K10 class in Taiwan. A 12-week (24h in total) pre- and post-test quasi-experimental study was designed. In the class we used the Arduino microcontroller, let students learn how to control the Arduino and design their final homework. All the course materials were placed in the school eclass network teaching platform (http://eclass.tcgs.tc.edu.tw). Students could log on to the network teaching platform at any time to view the materials and discuss with their partners. During the experimental period, we randomly selected students did the semi-structured interview to record their learning experience. The main statistic procedures employed for analyzing experimental data and testing the research hypotheses were Paired t-test. The result of this study: (1)The technology hands-on curriculum has a positive effect on students' technology attitude and programming attitude. (2)In the technology hands-on curriculum, students' technology attitude has a positive effect on students' programming attitude.(3) Data of semi-structured interview by qualitative analysis indicate that Hands-on Curriculum can generate students' motivation and interest to learn technology.

Keywords: Technology Hands-On Curriculum, Technology Attitude, Programming Attitude

Introduction

Taiwan believes that the content of technology education curriculum lies in the cultivation of concepts of technology. By operating the technology process, it is possible to deduce and understand the development of technology and hope that it can actually operate technology products and cultivate practical experience in the course. The topics of Taiwan's technology education curriculum mostly fall on the aspects of life technology (Yu-Sban Chang, Kuang-Chao Yu, Pei-Ru Hsiao, 2010). The technology curriculum is based on two subjects: Information Technology and Life Technology to implement curriculum concepts and goals. The basic concept of life technology curriculum is based on "Doing, Using, Thinking ". Develop students' ability to do practical work, the ability to use technology products, and the ability to design and critique technology. Teaching technology should be conducted in the form of problem solving or thematic production. Encourage students to conduct autonomous and exploratory learning so as to implement the curriculum concepts of "Design and Implementation" and " Computational Thinking ". Students apply various creative thinking methods in the formation of concepts, selection of materials, and processing techniques, and actually solve the tasks and problems delivered by teachers. This learning process is very difficult to do with other courses, and this is exactly the specialties of life technology courses (Yih-Hsien Chu, 2006). If we can make good use of practical courses in life technology and guide student with well-designed teaching materials, we will effectively develop students' abilities. So this study will effectively use Arduino online courses, and combined with eClass network teaching platform features, conducted a 12-week (24 lessons) technology Hands-on Curriculum. To understand the impact of technology hands-on curriculum on the technology attitude and programming attitude.

A. Technology Hands-on Curriculum

Technology education is a diversified curriculum, as an indispensable curriculum for people. Technology can lead people to a more advanced and convenient society. Therefore, the implementation of the technology education curriculum should not be neglected (Yu-Sban Chang et al., 2010). The technology curriculum is based on two subjects: Information Technology and Life Technology to implement curriculum concepts and goals. To help students understand the connection between science and engineering by strengthening the link between knowledge in different disciplines. Therefore, through the establishment of technology, the connotation of technology and engineering into the field of technology curriculum. To strengthen students' hands-on and interdisciplinary skills, such as science, technology, engineering, mathematics(STEM). Cultivate students' computational thinking, technological design and creative capabilities, and establish attitudes towards the technological society. Students apply various creative thinking methods in the formation of concepts, selection of materials, and processing techniques, and actually solve the tasks and problems delivered by teachers. This learning process is very difficult to do with other curriculums, and this is exactly the specialties of life technology curriculum(Yih-Hsien Chu, 2006).

Life technology belong to the hands-on curriculum in basic national compulsory education. Through the implementation of activities in the curriculum, teachers can develop students in metalworking, carpentry, circuit design skills. Instruct students to

understand the structure and planning of design and production. There are many similarities with the maker movement in such curricula. The basic concept of life technology curriculum is based on "Doing, Using, Thinking". Develop students' ability to do practical work, the ability to use technology products, and the ability to design and critique technology. Teaching technology should be conducted in the form of problem solving or thematic production. Encourage students to conduct autonomous and exploratory learning so as to implement the curriculum concepts of "Design and Implementation" and " Computational Thinking ".

Yi-Hsin Chang (2016) studied through problem-based learning on a given website （Web-PBL）, so that the impact on their learning attitude, problem-solving ability, and learning effectiveness on the science and technology fields is observed. Research result with implementation of the web-PBL program, the students' learning attitude on the science and technology is promoted with significance, particularly in the category of learning motivation, indicating that the students are holding a positive and active attitude on the web-PBL when they are engaged in the program. Mei-Hui Lu, Hsi-Yu Ching (2011) was discussing feasibility that applies Computer Aided Drawing (CAD) technique to elementary technology education course. The findings are the study has achieved better learning effects of CAD instruction in technology education course. Besides, the effects have inspired better learning motives.

Tai, Yu-Te, Ray, and Jia-Ling (2016) explored the influence of flipped teaching on students' learning achievement in living technology hands-on curriculum. Significant differences were found between the experimental groups and the control group in terms of students' learning achievement in living technology hands-on curriculum, technology attitude, cooperative learning attitude and course satisfaction.

Therefore, the technology hands-on curriculum of this study aims to cultivate students' hands-on capabilities. User Arduino microcontroller and C programming language design a series of hands-on curriculum. Expect to enhance students' technology attitude and programming attitude by this curriculum.

B. Technology Attitude

The attitude generally refers to the coordinated, organized, and habitual internal psychological response that an individual holds for anything. This complex psychological process is a collection of thoughts, emotions, and actions that are triggered by the things (Chun-Hsing Chang, Kuo-Shu Yang,1998). Chang-Wen Chen (2004) , Eagly & Chailen (1993) Attitude is a tendency for a person to make a positive or negative response to something, a person, a situation, or an event. Min-Tung,Lin (2006) Attitude refers to an abstract internal reaction of individuals to people, things, and objects. It manifests itself in external attitudes. Its connotation includes three parts: cognition, affection, and behavior. Gibson, Ivancevich, and Donnelly (2000) Stimuli can affect attitudes, and attitudes can be expressed specifically through the expression of personal preferences, the expression of beliefs, or the expression of actions. A positive attitude can be obtained through learning, and it is a persistent mental paradox. Developing a positive attitude is a part of school education that cannot be ignored.

The goals of technology education curriculum in various countries have been gradually changed from the manual exegesis emphasized in traditional craft courses to the development of students' technological literacy. It is also the three aspects of knowledge, skills, and attitudes of technology. In other words, besides attaching importance to scientific and technological know-how technology skills, how to guide students to have a correct technology attitude and to strengthen the training of relevant scientific and technological attitudes is an important aspect of the technology education curriculum. "Technology Attitude" refers to a person's tendency to cognize, affect, and act on information on technology. The cognitive part is the individual's belief in technology and technology issues. The emotional part is the inner feeling of the individual on the topics of technology. In the part of the behavior is the actual action shown by the individual on the issues of science, technology and technology (Min-Tung,Lin, 2006).

Jenkins (2006) pointed out that students like to work with new technologies. Students mention that it is interesting to work with new technologies, and technology is beneficial and important to society, medical training and life. Hsu, I-Ying (2012) aimed to discuss how the Living Technology Curriculum, containing the history of technology and science/ technology/ society (STS) materials, influenced students' technological literacy and attitude toward technology. The conclusions were as follows: (1) parents' occupations, the gender issue and academic performance affected students' performance in technological literacy and attitude toward technology; (2) content in the history of technology can enhance students' technological literacy and attitude toward technology; (3) students' attitude toward technology and academic achievement have positive influence on their performance in technological literacy. Tseng, Chang, Lou, and Chen (2013) pointed out students recognized the importance of STEM in the science and engineering disciplines; they mentioned in interview that the possession of professional science knowledge is useful to their future career and that technology may improve our lives and society, making the world a more convenient and efficient place. In conclusion, combining PjBL with STEM can increase effectiveness, generate meaningful learning and influence student attitudes in future career pursuit. Students are positive towards combining PjBL with STEM. Wendell and Rogers (2013) pointed out suggest that engineering design-based science curriculum units may support elementary students' science content knowledge, while helping students learn to design, construct, and test solutions to engineering problems. Because students using either curriculum had similarly positive attitudes toward science, our research suggests that the benefit of engineering design for science learning cannot be attributed simply to the positive science attitudes that may result from the use of novel materials or methods.

From the above research on technology attitude, we can see that students have a greater interest in technology (Jenkins, 2006). Hands-on activities such as PjBL through Life technology curriculum or STEM can improve students' technology attitudes (Tseng et al., 2013; Wendell & Rogers, 2013; Hsu, I-Ying, 2012). The attitude of technology has a positive effect on technological literacy (Hsu, I-Ying, 2012).

C. Programming Attitude

Computer programming is perceived as an important competence aiding in the development of higher-order thinking skills such as problem solving, creative thinking, logical reasoning, systematic experimentation and the like (Akcaoglu, 2014; Baytak & Land, 2011; Korkmaz, 2012; Lau & Yuen, 2009).Programming is an important lesson, but students often face learning obstacles due to abstract programming concepts. Computer programming is mostly perceived as a difficult course by the students (Askar & Davenport, 2009; Baser, 2013). Programming is a cognitive activity that requires plausible reasoning skills. It can cultivate students' ability to think high and make inferences in the process of learning. Cooper pointed out that it is difficult for beginners to understand the logical concepts (such as selection structures, loops, etc.) and data types (such as arrays) of program abstraction, because there are few real life examples to promote students' understanding in the introductory courses of programming (Cooper, Dann, & Pausch, 2003). Beaubouef and MasonAfter (2005) pointed out most students have studied a semester program, they still stay on grammar learning. It is difficult to apply the acquired program knowledge to plan the program. Although teachers explain the abstract idea of the program in the classroom, the programming teaching is often based on static teaching methods. It is difficult for learners to understand the operation and structure of the program (Hooper et al., 2007). The fact that computer programming is perceived as a difficult course results in the fact that they develop mostly negative attitudes regarding programming (Baser, 2013).Negative attitude regarding programming has a negative effect on the success of students. Hence, the studies finding out that such factors as negative perception, motivation and especially low level of attitude can make negative effect on learning computer programming take the attention(Anastasiadou & Karakos, 2011; Hawi, 2010; Korkmaz & Altun, 2013). The studies show that there is a significant relation between the accomplishment of tasks in the computer environment and the attitudes of students towards computer technology (Baser, 2013; Korkmaz & Altun, 2013).

Yu-Te Wang, Yuan-Tai Chen, Ling-Huei Tseng (2012) studied was to understand the effectiveness of robot programming courses in programming language course for female high school students. The main findings of this study were that there were no significant differences in students' programming achievement between experimental group and control group. Students' programming attitude of the experimental group was significantly different to the experimental group. Data of semi-structured interview by qualitative analysis indicate that robot programming courses can generate students' motivation and interest. Yu-Tzu, Liao (2011) developed two kinds of game-oriented teaching material with Greenfoot for programming concepts learning, and examined the effects of two kinds of game-oriented teaching material on high school sophomores' performance in programming learning, students' attitudes toward programming learning, and students' self-efficacy. Both groups of student attitude survey indicated that the majority of student had positive attitudes toward using the game-oriented teaching material to learn programming concepts.

HSU, TING-YU (2016) pointed out programming is an important lesson, but students often face learning obstacles due to abstract programming concepts. It is revealed in the research that the effects are better on senior high students' learning performances, self-confidence and abstract thinking ability in teaching programming for

experimental group than control group; besides, in interviews after class, students generally looked Scratch as an easy way to learn and it did arouse their interests, whereas fChart was more complicated to use but easier for them to observe the operation of the programming. Gençtürk and Korucu (2017) concluded that students receiving education within the experimental group are more successful. When analysing their attitudes towards programming languages, it is concluded that attitudes of students in experimental group are more positive than that of those in control group.

From the above research on programming attitudes, we can see that programming is an important course, but due to abstract programming concepts, students often face learning disabilities. The fact that computer programming is perceived as a difficult course results in the fact that they develop mostly negative attitudes regarding programming (Baser, 2013). Negative attitude regarding programming has a negative effect on the success of students. Hence, the studies finding out that such factors as negative perception, motivation and especially low level of attitude can make negative effect on learning computer programming take the attention(Anastasiadou & Karakos, 2011; Hawi, 2010; Korkmaz & Altun, 2013). The studies show that there is a significant relation between the accomplishment of tasks in the computer environment and the attitudes of students towards computer technology (Baser, 2013; Korkmaz & Altun, 2013). Learning programming through robots, games, etc. is more able to understand the role of programs and is more conducive to student motivation and interesting (Yu-Te Wang et al., 2012; Yu-Tzu, Liao, 2011).

Research methods

A. Samples

Unit	Subject	Description	Electronic parts	Programing	Time
1	Introduction Arduino and Arduino IDE	Arduino basic control instructions、Arduino IDE's operation interface		Arduino IDE C basic grammar	100 minutes
2	Arduino IDE programing	Arduino IDE programing	LED, resistance	variable, function, loop	100 minutes
3	LED Marquee	Use Arduino control 5 LEDs and produce different flickering effects	LED, resistance	variable, flow control, function, loop	100 minutes
4	Adjustable LED's brightness	Use Arduino's PWM pin and use variable resistance to adjust led's brightness	LED、variable resistance	variable, flow control, function, loop	100 minutes
5	Messaging	Computer and Arduino transfer data each other		variable, flow control, function, loop	100 minutes
6	Photoresistor night light (Homework 1)	Use photoresistor and LED design a night light	LED, photoresistor	variable, flow control, function, loop	200 minutes
7	Motor application	Use Arduino to control DC motor and Servo motor	DC motor, Servo motor	variable, flow control, function, loop	100 minutes
8	Bluetooth remote control car(Homework 2)	Use Arduino and Bluetooth module to design a Bluetooth remote control car	DC motor, Bluetooth module, L293 expansion board	variable, function, loop	400 minutes

The study sample consisted of forty two 16-year-old students from one K10 class in Taichung city of Taiwan. Two students form one group and the whole class is divided into 20 groups.

B. Technology hands-on curriculum

The technology hands-on curriculum of this research is mainly based on the ability to cultivate students' hands-on skills. The current popular Arduino microcontroller is the main feature, and the C program language is used to design a series of hands-on applications for life (Table 1). The curriculum was placed in the school's eclass network platform (http://eclass.tcgs.tc.edu.tw).

Table 1 Technology Hands-on curriculum

C. Research tools

1. Technology scale

The technology attitude scale was compiled by Tai et al. (2016). The technology attitude scale of this study is divided into following five sub-scales: Technology career, Technology interest, Technology problem, The importance of technology and Technological difficulties. The Cronbach α of whole scale and each sub-scale are shown as follows: the Cronbach α of Technology career is 0.91; Technology interest is 0.76; Technology problem is 0.91; The importance of technology is 0.76; Technological difficulties is 0.86; and the Cronbach α of whole scale is 0.91.

2. Programming scale

The programming attitude scale was compiled by Tai, D. W. S., Liang-Chu Lai (2016). The programming attitude scale is divided into following five sub-scales: usefulness, confidence, preference, anxiety, and course requirements. The Cronbach α of whole scale and each sub-scale are shown as follows: the Cronbach α of preference is 0.80; usefulness is 0.71; confidence is 0.75; anxiety is 0.83; course requirement is 0.82; and the Cronbach α of whole scale is 0.90.

3. Qualitative data collection and analysis

This study use qualitative data research procedure reference from Ya-Chu Yang, Hsiao-Lin Tuan (2015) and Sung-Pei Chien, Hsin-Kai Wu(2008). Qualitative data analysis to analyze the open questionnaire after the completion of two Hands-on homework. Qualitative data is coded according to the purpose of research. The contents of the code list (Table 2) cover the course satisfaction and technology attitude. The number of open questionnaires for the hands-on units in this study, homework1 has 40 questionnaires, and homework has 40 questionnaires. Firstly, the researcher analyzes the open questionnaire, then to co-analysts. Analytical results are discussed and confirmed multiple times.

Table 2 Qualitative data encoding table

Item	Code number	Definition	Description
course satisfaction	1-1	Students feel diverse in the content of the course. The textbooks can assist in the completion of homework.	The student mentioned that the course is rich in content, and that watching the teaching video or the teacher's textbooks can help the team complete the homework
	1-2	Satisfied teacher content, feedback quality and timely assistance	Students feel that teachers can provide advice and guidance at the right time and respond to the problems encountered
	1-3	Students feel that the course makes them self-growth	Due to the relationship of this course, students feel that they have increased their confidence in their scientific knowledge and hands-on skills.
	1-4	Students look forward to the next hands-on curriculum	Students find the course very interesting and are looking forward to the next hands-on curriculum
technology attitude	2-1	Have confidence in technology	Students mentioned that through this course, they feel more confident in technology and hands-on
	2-2	Like programming or technology implementations	Students like programming and hands-on implementations, and they mention that technology is very interesting
	2-3	Ability to apply technology to everyday life or generate interest in technology	Students can apply what they have learned in daily life to daily life, or actively observe technology-related products in daily life.
	2-4	Demonstrate technology-related career planning	Students would like to study in related science and technology departments or would like to work in the field of technology.

Research results

A. The Impact of Technological Hands-on Curriculums on Technology Attitude and Programming Attitude

This study want to understand the impact of technological hands-on curriculum on technology attitudes and programming attitudes. Use paired t-test to examine the difference between on technology attitudes and programming attitudes after the 12-week technology hands-on curriculum. The paired t-test results of the pretest and posttest of the technology attitudes scale and programming attitudes scale are shown in Table 2 and Table 3 below. According to the results on Table3, there were have significant differences between the pretest and posttest results of total scale, technology career and technology interest on the technology attitude scale. According to the results on Table4, there were have significant differences between the pretest and posttest results of all sub-scales and total scale.

Table 3 The Paired t-test on the technology attitude scale

sub-scale	Pretest		Posttest		t
	Mean	Std	Mean	Std	
Technology career	28.21	5.63	30.08	4.63	2.79**
Technology interest	15.00	2.67	16.05	2.45	2.78**
Technology problem	32.44	5.83	33.00	5.20	.89
The importance of technology	17.67	2.40	18.13	2.08	1.42
Technological difficulties	14.85	3.38	15.44	2.70	1.47
Total scale	108.15	14.86	112.69	11.99	3.53**

N=39;*p<.05,**p<.01,***p<.001

Table 4 The Paired t-test on the programming attitude scale

sub-scale	Pretest		Posttest		t
	Mean	Std	Mean	Std	
preference	20.64	4.93	22.87	4.61	3.25**
usefulness	23.87	3.09	28.03	4.65	6.36***
confidence	15.82	4.56	17.33	3.95	2.58*
anxiety	13.46	3.02	15.64	3.41	4.12***
course requirements	18.87	3.50	20.79	3.90	3.16**
Total scale	92.67	16.41	104.67	17.92	5.24***

N=39;*p<.05,**p<.01,***p<.001

B. The influence of technology attitude on programming attitude in technology hands-on curriculum

This study to understand the influence of technological attitude on programming attitude in the technology hands-on curriculum. Use independent t-test to examine the difference on the programming attitude between the technology attitude scale pretest high group and low group. According to the results on Table 5, the technology attitude scale high group's average score is 113.00 on the programming attitude scale. T low group's average score is 94.94. T independent t-test is 3.597**. The results show the student's programming attitude score in the technology attitude scale high group is better than the low group. From the above results, the technology attitude in the technology hands-on curriculum does affect the programming attitude.

Table 5 independent t-test

	Group	People	*M*	*SD*	*t*	*p*
Technology	HIGH	21	113.00	11.62	3.597**	<.01
Attitude Pretest	LOW	18	94.94	19.31		

N=39;*p<.05,**p<.01,***p<.001

C. Qualitative data analysis

This study was based on an open questionnaire qualitative data analysis. According to the results on Table 6, 96.25% of students mentioned that they are satisfied with the technology hands-on curriculum. In the course satisfaction item, 25% students feel diverse in the content of the course. The textbooks can assist in the completion of homework. 15% students satisfied teacher content, feedback quality and timely assistance. 40% students feel that the course makes them self-growth. 16.25%

students look forward to the next hands-on curriculum. This curriculum leads student to understand the function of Arduino. And the content of the technology hands-on curriculum is very close to life. Students can successfully make interesting and practical devices through the guidance of this curriculum. Student think the curriculum is very challenging and interesting.

Table 6 Hands-on qualitative data times table

Item	Code number	Definition	Time	% (Time/80)	Total	% (Total /80)
course satisfaction	1-1	Students feel diverse in the content of the course. The textbooks can assist in the completion of homework.	20	25%	77	96.25%
	1-2	Satisfied teacher content, feedback quality and timely assistance	12	15%		
	1-3	Students feel that the course makes them self-growth	32	40%		
	1-4	Students look forward to the next hands-on curriculum	13	16.25%		
technology attitude	2-1	Have confidence in technology	43	53.75%	79	98.75%
	2-2	Like programming or technology implementations	25	31.25%		
	2-3	Ability to apply technology to everyday life or generate interest in technology	7	8.75%		
	2-4	Demonstrate technology-related career planning	4	5%		

＊ 40 students, everyone write two open questionnaires

In addition to technology attitude, 98.75% of students mentioned their views on technology. 53.75% student have confidence in technology. 31.25% student like programming or technology implementations. 8.75% student ability to apply technology to everyday life or generate interest in technology. 5% student demonstrate technology-related career planning. After participated in technology hands-on curriculum, student feel very satisfied after completing the homework. And then find out about their interest in programming. This shows that this course can stimulate students' interest in technology, and then improve students' technology attitude.

Conclusion and suggestion

A. Conclusion

1. The technology hands-on curriculum has a positive effect on students' technology attitude and programming attitude.

This Study used paired t-test to examine the difference between on technology attitudes and programming attitudes after the 12-week technology hands-on curriculum. According to the results, there were have significant differences between technology attitude and programming attitude after technology hands-on curriculum. And from the student's qualitative information can also be found after participated in

technology hands-on curriculum, student feel very satisfied after completing the homework. And then find out about their interest in programming. This shows that this course can stimulate students' interest in technology, and then improve students' technology attitude. The results of this study are the same as many studies. Students like to participate in technology work, students mentioned that it is interesting to work with new technology. And technology are beneficial and important to society, medical training and life. Students' attitudes in engineering and technology increase slightly after participating in technology activities (Jenkins, 2006; Tseng et al., 2013). Through technology hands-on curriculums, students can not only practically use STEM knowledge, but also can actively engage in STEM integration concepts in the topic of technology implementation.

2. In the technology hands-on curriculum, students' technology attitude has a positive effect on students' programming attitude.

This study used independent t-test to examine the difference on the programming attitude between the technology attitude scale pretest high group and low group. The results show the student's programming attitude score in the technology attitude scale high group is better than the low group. From the above results, the technology attitude in the technology hands-on curriculum does affect the programming attitude. The results of this study are the same as many studies. Students feel unfamiliar with programming. However, after hands-on curriculum, they can understand the use of programming. Learning the programming through hands-on curriculums such as robotics and Arduino can better understand the role of the program and can be more conducive to student motivation and interest. It can influencing students' programming (Gençtürk & Korucu, 2017; Yu-Te Wang et al., 2012).

3. Data of semi-structured interview by qualitative analysis indicate that Hands-on Curriculum can generate students' motivation and interest to learn technology.

According to the qualitative data of students shows that technology hands-on curriculums can really enhance students' motivation and interest in learning technology. This course leads student to understand the function of Arduino. And the content of the technology hands-on curriculum is very close to life. Students can successfully make interesting and practical devices through the guidance of this course. Student think the course is very challenging and interesting. The results of this study are the same as many studies. Completion of the tasks in the programming course has a significant relationship with the student's programming attitude (Baser, 2013; Korkmaz & Altun, 2013). Through technology hands-on courses, students' technology attitudes have improved significantly. Especially in the part of learning motivation, the promotion is most obvious, which can motivate the students' motivation and interest in learning technology (Tai et al., 2016; Mei-Hui Lu et al., 2011; Yi-Hsin Chang, 2016). Learning programming through robots, games, etc. is more able to understand the role of programs and is more conducive to student motivation and interesting (Yu-Te Wang et al., 2012; Yu-Tzu, Liao, 2011).

B. Suggestion

This study was only experimental teaching in senior high schools in Taiwan, but also experimental teaching in only one class due to school scheduling factors. The study

found that technology hands-on curriculum significantly improved students' attitude in science and technology and programming attitude. Suggest that can increase the experiment class and control group in future. In addition, the experimental teaching materials placed in advance online teaching platform, it is suggested that different teaching strategies (such as flip teaching, cooperative learning) to explore different teaching strategies in technology hands-on curriculum for technology attitude and programming attitude.

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