

The correlation between participating extramural programming courses and children's intelligence development

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Abstract: Recently, artificial intelligence has been developed at an surprising speed and used in different aspects in our society. In fact, robot programming courses have become a hot topic being discussed in the education sector. Since 2014, computer education reform in primary and secondary schools worldwide has advanced programming courses to the first grade of primary school or even pre-school stage[1]. Therefore, an increasing number of parents enroll their children to robot programming training courses. The father of children's programming education Mitchel Resnick [2] believe programming is a kind of education that allows children to creatively address practical problems by thinking in a way that how programs run and this goal has become the recruitment and promotion slogans used by various programming training institution. However, whether extramural programming courses can actually achieve the goal claimed or they are just a so-called 'stupid tax' paid by parents remains to be a widely discussed and controversial topic. Based on Wechsler Intelligence scale of children fourth edition measurement scale [3], our research conducts an intelligence test for 50 children, with an average age of 10 and who are attending programming courses, to find out whether participating extramural programming courses can indeed enhance children's problem-solving skills and calculation capacity.

1. Introduction

By conducting experiment, Berson and his team [4] found out that computer programming courses can enhance students' different ability. Firstly, it is cognitive ability. Through programming, people need to break down problems into smaller parts, find solutions, and clarify implementation steps. This thinking process helps to cultivate logical thinking, creative thinking, and problem-solving abilities. Secondly, computational thinking ability and programming often involve the application of algorithms and data structures, which makes programmers need to reflect mathematical thinking in code. Thirdly, mastering programming can help deepen the understanding of mathematical concepts and cultivate Abstraction and computing ability. Such theory has become the foundation of extramural programming training courses for enrollment and promotion as well as the ultimate goal of their education. When parents of children hear that they can improve their children's many abilities

and achieve comprehensive intellectual development, programming courses have become a very popular extracurricular course currently.

However, Mitchel Resnick [5] holds the belief that learning robot programming requires long-time practice and exploration in order to actually master and apply such techniques as well as concepts. Based on the learning theory, when Ebbinghaus was investigating human memory, it was found that the curve of memory-forgetting appears the downward trend of the index. He believed that through repeated revision, the retention time as well as retention degree of memory can be lengthened and improved. Combing the background theory of programming and the theory of memory, we can conclude that learning programming is a long-term task that requires consolidation and review.

So now we have a question, is it true that off campus programming courses are taught according to the laws of children's development, do teachers really have professional knowledge, and can they really improve children's intelligence and other comprehensive abilities?

According to the investigation about 10 after-school programming-training institutions located in Guiyang City, China: students can only learn and program in classes due to the limitation in equipment and venue. Therefore, they cannot do any revisions about what they learnt after coming back to home. Since there is only one lesson with a duration of 60-90 min each week. As a result, this kind of learning pattern cannot align with the theory of repeated revision. Besides, according to < Law of the People's Republic of China on Teachers >, <Regulations on the Qualifications of Teachers> and other laws, teachers must have teaching certificates, hence no matter from the view of legal issues or education, teachers having relevant education knowledge and Teachers Qualification are both of crucial importance. Nevertheless, most teachers in those extramural programming-training institutions only holds Bachelor degrees in computer science, but not in education. Moreover, no direct evidence shows that these teachers have teaching certificates or have learned pedagogy-related theory and knowledge. So there is the first question, whether teachers outside of school have teaching qualifications or the necessary teaching level, which is difficult to verify. Additionally, each institution will teach different skills and techniques, ie. Heterogeneous teaching content. Therefore, it is difficult to evaluate or decide whether these institutions teach students in accordance with curriculum standard. There is a second question, where do their teaching models come from and whether as teaching institutions, they will update their teaching concepts and models. Some institutions even promote their teaching experience gained through learning the theories of Simore Papatt, a pioneer in artificial intelligence and the father of the LOGO programming language. But it is hard to verify whether they have actually studied. The current teaching mode and theory of after-school programming courses are clearly not in line. So there is a big question: whether extracurricular programming courses can improve children's intelligence and achieve the expected teaching objectives? So our research is skeptical about whether extramural programming-training institutions can enhance children's logic-thinking ability, mathematical reasoning and arithmetic ability.

Wechsler Intelligence scale of children fourth edition measurement scale is International General Intelligence Scale, through speech comprehension, perceptual reasoning, processing speed and working memory four aspects, we can summarize the intelligence test for 6-16 ages children. Among the four aspects, perceptual reasoning consists of building blocks, graphic concepts, matrix reasoning and calculating. These four areas comprehensively test candidates' problem-solving capacity, reasoning skills, spacial perception and visual organization ability as well as calculating ability. Therefore, this research is based on Wechsler Intelligence scale of children fourth edition measurement scale to investigate whether extramural programming courses can actually strengthen children's problem-solving skills and calculation capacity or not.

2. Method

2.1 Participants

Through investigation, our research chose 50 primary four students aged between 10-11. For the first group, there are 12 boys and 13 girls with a total number of 25. All group members of the first group have not participated any robot programming courses in school or outside the school. The second group consists of 11 boys and 14 girls, with a total number of 25 students. They have attend after-school programming courses for one year or above. Their classes frequency is one lesson each week with a duration of 60-90 min each time. Besides, all participants have been surveyed, the questions include student satisfaction with the programming course, family monthly income and the education level of parents. Details are showed in Table 1. This research set a requirement for the education level of parents so the parents of all students have at least an associate degree or a higher level degree. Besides, the family monthly income of all students are around 5000 RMB. Moreover, all students come from the same school to minimize the potential impacts of some factors such as education level of parents, teaching quality, economic level, teaching level, culture and geographic area on the development of the intelligence of students.

Table 1: Participant's basic information

variable	Total (n=50)	Participate (n=25)	non-participate (n=25)
Mother's education level(%)			
Below the high school	0(0)	0(0)	0(0)
Associate/bachelor	47(94%)	24(96%)	23(92%)
Above the master	3(6%)	1(4%)	2(8%)
Father's education level(%)			
Below the high school	0(0)	0(0)	0(0)
Associate/bachelor	44(88%)	24(96%)	20(80%)
Above the master	6(12%)	1(1%)	5(20%)
Family total salary/month(China Yuan)			
≤5000	0(0)	0(0)	0(0)
5001—12000	12(24%)	5(10%)	7(28%)
≥12001	38(76%)	20(90%)	18(72%)
Satisfaction with the course			
Satisfaction≥90	×	23(90%)	×
80 ≤Satisfaction≥89	×	2(8%)	×
50 ≤Satisfaction≥79	×	0(0)	×
49 ≤Satisfaction	×	0(0)	×

2.2 Material

Prepare Chinese version of Wechsler Intelligence scale of children fourth edition measurement scale: The fourth edition of the Wechsler Children's Intelligence Scale (WISC-IV) is aimed at primary and secondary school students aged 6-16. It has been officially released and used in North America since 2003, and has a great reputation. It is one of the most famous, authoritative, and effective

intelligence measurement tools in the world.

The four indicators used to illustrate children's cognitive abilities in different fields are:

1) Speech Comprehension Index: Each subtest of the Speech Comprehension Index is mainly used to measure language learning ability, concept formation, abstract thinking, analytical generalization ability, etc. This index helps teachers and parents better understand children's speech ability, and plays a better screening role for children with speech Developmental disorder.

2) Perceptual Reasoning Index: Each subtest of the Perceptual Reasoning Index mainly measures a person's reasoning ability, spatial perception, visual organization, etc. Compared with previous scales, this index can more accurately measure the participants' nonverbal reasoning ability. It helps parents and teachers better understand their children's reasoning and spatial thinking abilities.

3) Working memory index: Working memory index mainly reflects people's memory ability, ability to understand and apply foreign information. Working memory is an important measure of people's learning ability. This index can accurately help people understand children's attention, memory ability and reasoning ability.

4) Processing speed index: Processing speed measures a person's understanding speed of simple external information, speed and accuracy of recording, attention, writing ability, etc. Daily learning and life often require individuals to have the ability to process both simple information and complex information. Individuals with slower processing speeds often require longer processing times

And other tools such as test handbook, handbook appendix, test equipment including score card, marking pen, paper and pencil. The tables are all printed.

2.3 Process

The whole test lasts for one week. 10 psychologists with medical qualifications carried one-by-one test with students in school. The test duration is about 1.5-2 hours. This time is consistent with the performance profile of the Wechsler Intelligence Scale for Children - Fourth Edition [3]. Each psychologist will record the data of their candidates and in total there are 50 data. Before the test, students will be randomly distributed to different psychologists to ensure the psychologists do not know the background as well as the children's participation in robot programming in advance. All data from this test is anonymous and will not be released to schools, students, teachers or parents to protect student privacy.

3. Result

According to table 2, the average intelligence level of students who have participated programming-training is 103.61 while those who have not participated any training is 103.49, $P \geq 0.05$, these two data do not show significant difference. In terms of perceptual reasoning intelligence, students joining programming courses have an average score of 107.16 while those who have not joined got 109.24, showing a difference of 0.892, $P \geq 0.05$. Since there is no a significant difference between the two data, this proves that participating extramural programming-training course will not cause a significant difference in children's overall intelligence or perceptual reasoning intelligence.

Table 2: The comparison of student's intelligence

	Total Score		Boys Score		Girls Score	
	Participate	Non-participate	Participate	Non-participate	Participate	Non-participate
Speech comprehension	100.52	101.76	98.24	107.86	102.24	94.72
Perceptual reasoning	107.16	109.24	108.01	109.78	105.61	108.11
Working memory	109.12	104.2	108.07	104.21	109.38	104.24
Processing speed	97.64	98.76	101.33	101.14	93.71	95.66
Intelligence	103.61	103.49	103.91	105.74	102.73	100.68

4. Conclusion

Whether joining extramural programming-training courses can enhance students' perceptual reasoning: this research found that for those who joined such courses and those who did not, there is no significant difference in perceptual reasoning intelligence. Besides, regardless of gender, candidates' verbal comprehension, working memory, processing speed and total IQ shows no significant difference. Regarding this phenomenon, we made the following discussion:

The teaching time of extramural programming-training courses is too short and insufficient. According to the theory of memory-forgetting curve proposed by Ebbinghaus [1]: after learning new things, 40% of knowledge learnt will be forgot in 20 mins. Without any repeated revision, after 24 hours, only 20% of messages can be mesmerized. Therefore, only by the once-a-week 60-90 min lesson and without any subsequent repeated revision, students can hardly master and apply what they have learnt. So far, robot programming courses are limited by venue, equipment, the exorbitant price as well as the lack of repeated revision in home. How to address such problems in order to allow students to practice in home remains a new research direction for the development of programming courses and its curriculum.

Therefore, when choosing extramural transiting institution, parents have to be careful. They should only choose those with relevant teaching qualifications and ought also to consider the suitability of their course curriculum in order to allow their kids to master and apply the knowledge.

In addition to the constraints of location and time, genetic factors also constrain the development of intelligence. According to American psychologist Burt [6], intelligence is affected by inheritance but not environmental factors. Therefore, whether courses can improve students' intelligence still require more evidence.

Although there is no significant difference in intelligence level and fluid intelligence level, this does not mean that such courses are ineffective and useless. According to Hmelo-Silver [7], an effective course can not only achieve the final education goal, but also arise the interest and passion of participants. In the investigation of 50 students who are attending extramural programming courses, a majority of them find this kind of course interesting. They feel enjoyable during lessons and think their communication and collaboration skills are strengthened, making them a better team member. As a result, extramural programming courses may not improve students' IQ, but may enhance their ability to work in a team as well as social and communication skills.

In addition, according to the 35 competitions announced by the Chinese Ministry of Education in 2021, 13 of them are related to programming, including the National Youth Artificial Intelligence Innovation Challenge and the Chinese Youth Robot Competition. According to relevant regulations,

if students can win awards in such competitions, In the final total score, it will obtained a maximum of 20 extra points in the final total scores. So that will be easier to enter high school and university. And such regulations are still valid in European and American countries. This means that if you can win awards in programming competitions, although it may not improve your IQ, it can enhance your competitiveness in university's enrollment. So studying such courses is not completely meaningless.

In summary, for such courses, parents need to have a rational view and understand the needs of themselves and their children. If you want your child to have a pleasant lesson experience, enrich extra-curricular knowledge, or want your child to better communicate, cooperate, and learn with peers. Such courses can meet such needs. Alternatively, parents may want their children to have a better resume and receive such awards to apply for a better school. If they can carefully choose a good training institution, they may also be able to meet the requirements of qualified teachers, excellent teaching quality, and children's cooperation. However, if we want to achieve a qualitative development of children's intelligence through this course, showing a different level of intelligence compared to peers, based on the limitations of the extracurricular programming course proposed by this study and the theory that intellectual development is more influenced by genetics, this goal is difficult to achieve.

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