Ilkogretim Online - Elementary Education Online, 2021; 20 (3): pp. 1068-1074
http://ilkogretim-online.org
doi: 10.17051/ilkonline.2021.03.117

A Study on the Effect of Language Ability on Programming Interests

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Abstract. This study aimed to identify the effects of three kinds of language competence on three kinds of programming interests. This study's participants consisted of 39 college students who had begun to learn C programming. It classified language competence into "reading", "writing", and "grammatical understanding", and programming interests into "situational interest", "latent interest", and "actualized interest", and analyzed the effects of each variable of those three groups. This study used Pandas for analysis, and performed reliability testing, descriptive statistics analysis, correlation analysis, and regression analysis. Pearson's correlation coefficients between the three items on language competence and the three items on programming interests were as follows: .54 ~ .88 in the first survey; .54 ~.95 in the second survey; and .66~.94 in the third survey. All the p values were <.01. In the first survey done after students learned data, the a_value was 25.016 and the b_value was 0.256. In the second, the a_value was 23.009 and the b_value was 0.275. In the third, the a_value was 18.237 and the b_value was 0.330. The R_squared values for the first, second, and third surveys were .530, .564, and .747, respectively. The performance evaluation results showed that the mean squared errors for the first, second, and third surveys were 30.924, 30.645, and 22.069, respectively. In addition, the RMSE errors for the first, second, and third surveys were 5.561, 5.536, and 4.698, respectively. This study identified that language competence has positive effects on programming interests, helping learners improve their programming writing strength.

Keywords: Language competence, novice programmer, programming competence, Psychology of Programming.

Received: 04.12.2020	Accepted: 15.01.2021	Published: 07.02.2021

INTRODUCTION

The programming process is a mental process that involves deeply complex human thinking, and it requires very diverse and integral competencies, including language competence, logical thinking, and problem-solving strengths[1,2]. The comprehensive and diverse knowledge activities needed for programming make it difficult to measure major elements of the programming process[3]. In addition, as the process also includes the characteristics whereby persons cooperate through mutual interaction, it becomes very difficult to observe and measure knowledge activities to find a methodology for improving programming strength[4].

In addition, with the transition from the information-oriented society to the intelligent information society, human resources in various areas of expertise such as humanities, society, sports, and health as well as science and engineering should learn programming to analyze data in each area and learn artificial intelligence[5,6]. Accordingly, computer programming has expanded beyond the concept of learning strengths and learning achievement, and, in the sense of a methodology to improve and develop personal competency, programming strength has become urgent and necessary[7].

It is not known how much language competence, a factor that greatly affects programming competency, affects interest in programming. Therefore, this study attempts to identify what effect language competence, which is known to have a great effect on programming among various kinds of abilities, has on programming interests.

Theory and formula

Programming involves very internal psychological activities, and proceeds through humans converting the inner structures of their thought systems into surface structures[8]. Further, language knowledge has a strong effect on understanding computer programming language. Language knowledge is very important in the process of understanding the sentence structure of program language as well as writing and

interpreting code. By reading the names of variables and functions along with reading and interpreting comments, one can intuitively understand the whole structure of programming.

To write code, the linguistic ability to write the names of variables, functions, and comments is deeply related to language knowledge. It is also deeply related to the linguistic ability to listen to an explanation of the program already written, then conceptualize it and make it into a function. As such, reading, writing, and listening to programs are related to language use process, and these various elements interact with each other, thus enhancing the understanding and use of the programming language[9,10].

Further, those who major in programming need to spend a long time learning to acquire the results of knowledge activities. To overcome the difficulties encountered in that long period of time, they must maintain interest in their major[7,10]. Interest in programming can be a driving force for overcoming the various problems they might face in the two to three years necessary to equip programmers with the ability to work in business. For those who do not major in programming and cannot a spend long time learning programming, it is of utmost importance to maintain interest in programming to cultivate integrative competency for programming.

While there has long been research into the psychology of programming, the importance of language competence has not been seriously considered to date. Furthermore, there have been very few efforts to link linguistic learning made in the period of basic learning and programming knowledge. Accordingly, to use it, we need to elucidate the effect linguistic knowledge has on programming knowledge.

In particular, programming education should be expanded to the perspective of individual competence. In the educational field, programming interest is considered the basic concept which should be maintained to improve the competency of the programmer. Therefore, it is necessary to examine how linguistic knowledge affects programming interest. In programming psychology, there are no operational definitions of linguistic competence in computer programming or programming interest. Accordingly, this study presents operational definitions of linguistic competence and programming interest, as well as the effect linguistic competency has on programming interest.

Method of Study

To measure the effect of language competency on programming interest, this study selected 39 college students taking a basic course in C programming, and administered the survey to them three times on reading, writing, grammatical understanding, and programming interest. Responses to each question were measured with a 7-point Likert scale. The measurement results consisted of reliability testing, descriptive statistics testing, correlation analysis, and regression analysis (N = 39). To conduct the experiments, this study used Pandas. Question items used to measure grammatical understanding are listed in Table 1.

Table 1: Language Competence Questionnaire

Reading C programming	LA1: I can read all the sentences related with calculation of C language I have learned up to now.
	LA2: I can read all the sentences related with control of C language I have learned up to now.
	LA3: I can read all the sentences related with saving of C language I have learned up to now.
	LA4: I can read all the sentences related with input of C language I have learned up to now..
	LA5: I can read all the sentences related with output of C language I have learned up to now.
	LA6: I can read various English expressions inscribed on the tools used in coding.
	LA7: I can understand various English expressions inscribed on the tools used in coding.
	LA8: I can read English expressions on results and error produced in the execution of programming.
	LA9: I can understand English expressions on results and error produced in the execution of programming.
Writing C programming	LA10: I can write all the sentences related with calculation of C language I have learned up to now.
	LA11: I can write all the sentences related with control of C language I have learned up

	to now.
	LA12: I can write all the sentences related with saving of C language I have learned up to now.
	LA13: I can write all the sentences related with input of C language I have learned up to now.
	LA14: I can write all the sentences related with output of C language I have learned up to now.
Understanding the C programming Syntax	LA15: C programming grammar asks me to express thinking of too many levels.
	LA16: I can easily intuitively grasp C programming grammar.
	LA17: C programming is too wide in its grammar.
	LA18: I understand the grammatical structure (procedure, choice, and repetition) of C programming I have learned up to now.
	LA19: I can explain the grammatical structure (procedure, choice, and repetition) of C programming I have learned up to now.
	LA20: There are too many strange concepts in C language grammar. (reverse question)

To conduct education in terms of competency, interest is classified into situational interest and individual/personal interest, and individual interest is further classified into latent interest and actualized interest. The survey contents are presented in Table 2.

Table 2: Programming Interest Questionnaire

Situational interest	IQ1: I feel that the C programming is interesting.
	IQ2: Learning C Programming would be useful to me.
Latent interest	IQ3: If I study hard, I will be able to get great grades in the C programming class.
	IQ4: I try to concentrate on the C programming class and practice hours.
	IQ5: I am trying to actively participate in the C programming class.
	IQ6: In the future, I will study harder in the C programming class than now.
Actualized interest	IQ7: I like the current teaching method of C programming class.
	IQ8: I feel more interested in the current C programming class than other classes.
	IQ9: My programming ability has been improved by the C programming class.

The college students who were studying basic programming learned repetition sentences and functions of the C programming learning process, and were then asked to respond to the first set of the survey. After learning 1D array, they were given the second set of the survey. After learning the basics of pointer, they were given the third set of the survey. In each process, the correlations between language understanding, such as reading, writing, and grammar understanding of programming, and interest (individual interest, latent interest, and actualized interest) in computer language were measured. In addition, to measure changes in group, this study used regression analysis. The three-times measurements were conducted after students practiced problem-solving through programming tasks.

Result and Discussions

To measure the language abilities of the college students who participated in this work, this study conducted descriptive statistic analysis. There were nine questions on language competence (LA1~LA9), five questions on writing competence (LA10~LA14), and six questions on grammatical understanding (LA15~LA19). The survey on language competence was conducted three times, and the results are listed in Table 3. In the first survey, the mean and the standard deviation on the 7-point scale were 2.31~5.03 (1.17~1.61), respectively; in the second survey, they were 2.95~4.95 (1.18~1.55), respectively; and in the third survey, they were 2.67~5.21 (1.00~1.79), respectively.

Table 3: Results of Analysis on Language Competence

(N:39)

	First		Second		Third	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
LA1	4.871795	1.379922	4.794872	1.435994	5.076923	1.511093

LA2	4.717949	1.485876	4.692308	1.524430	5.000000	1.521772
LA3	4.846154	1.348263	4.871795	1.507516	5.000000	1.486784
LA4	4.820513	1.519553	4.846154	1.460686	5.128205	1.472189
LA5	4.923077	1.421352	4.948718	1.520885	5.179487	1.519553
LA6	4.641026	1.347262	4.743590	1.516887	5.205128	1.435994
LA7	4.461538	1.553369	4.641026	1.495382	5.128205	1.417550
LA8	4.179487	1.636295	4.692308	1.360221	5.076923	1.421352
LA9	4.256410	1.601282	4.589744	1.463916	4.923077	1.579217
LA10	4.461538	1.501686	4.692308	1.541596	4.897436	1.552500
LA11	4.282051	1.605070	4.615385	1.549455	4.871795	1.592408
LA12	4.384615	1.599595	4.717949	1.520885	4.897436	1.552500
LA13	4.538462	1.501686	4.717949	1.413259	4.897436	1.500787
LA14	4.461538	1.553369	4.794872	1.360717	4.974359	1.512878
LA15	4.794872	1.173826	4.641026	1.180704	4.794872	1.398862
LA16	4.102564	1.518220	4.282051	1.468058	4.564103	1.465298
LA17	5.025641	1.266723	4.948718	1.234349	5.179487	0.996620
LA18	4.487179	1.636295	4.564103	1.428928	4.897436	1.569359
LA19	4.307692	1.672594	4.538462	1.519109	4.692308	1.794052
LA20	2.307692	1.173251	2.948718	1.468058	2.666667	1.474937

The questions on programming interest consisted of two questions on situational interest (IQ1~IQ2), four questions on latent interest (IQ3~IQ6), and three questions on actualized interest (IQ7~IQ9). Those questions were also asked three times, as presented in Table 4. In the first survey, the mean and the standard deviation on the 7-point scale were 4.34~6.05 (0.90~1.68), respectively; in the second survey, they were 4.69~5.92 (1.02~1.56), respectively; and in the third survey, they were 4.77~6.13 (0.86~1.65), respectively. The results show that as measurements are repeated, the mean values go up.

Table 4: Results of Analysis on Programming Interest (N:39)

	First		Second		Third	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
IQ1	4.846154	1.630926	4.692308	1.558573	5.256410	1.584762
IQ2	5.743590	1.163433	5.769231	1.087284	6.128205	0.863880
IQ3	4.948718	1.685054	5.076923	1.243607	5.410256	1.568069
IQ4	6.025641	0.986412	5.820513	1.022685	6.000000	1.123903
IQ5	5.923077	0.899843	5.717949	1.074800	6.000000	1.169795
IQ6	6.051282	0.971941	5.923077	1.085420	5.923077	1.243607
IQ7	4.589744	1.332152	5.153846	1.308645	5.076923	1.222263
IQ8	4.333333	1.382852	4.820513	1.253874	4.769231	1.645753
IQ9	5.282051	1.503482	5.435897	1.333671	5.717949	1.234349

To examine the relationship between the three groups measured on language competence and another three groups measured on programming interests, this study conducted correlation analysis. The correlations in the first measurement are listed in Table 5, and the values were significant at the $p<.01$ level. In the second and third measurements, the values are similar, and they were all significant at the $p<.01$ level.

Table 5: Relationship between Language Competence and Programming Interest (First survey)

(N:39)

	Situational interest	Latency interest	Actualized interest	Reading	Writing	Grammatical understanding
Situational interest	1					
Latency interest	.76**	1				
Actualized interest	.72**	.65**	1			

Reading	.66**	.66**	.61**	1		
Writing	.64**	.54**	.62**	.87**	1	
Grammatical understanding	.67**	.62**	.61**	.88**	.81**	1

**: p < .01

Reliability tests were conducted between the three groups on language competence and another three groups on programming interests. For the three groups on programming interests, Cronbach's alpha coefficients for situational interest, latent interest, and actualized interest were .530, .791, and .585, respectively. Those coefficients have increased in the second and third surveys. In the third survey, the values reached up to .619, .921, and .787, respectively. By contrast, for the three groups on language competence, Cronbach's alpha coefficients for reading, writing, and grammatical understanding were .958, .987, and .699, respectively. The coefficients in the second and third surveys were similar, showing insufficient research on language competence and lack of operational definitions. The specific Cronbach's alpha coefficients are presented in Table 6.

Table 6: Results of Cronbach's Alpha

	First	Second	Third
Situational interest	.530	.728	.619
Latency interest	.791	.891	.921
Actualized interest	.585	.697	.787
Reading	.958	.979	.980
Writing	.987	.990	.990
Grammatical Understanding	.699	.536	.727

To analyze the effect of language competence on programming interests, this study conducted regression analysis. In the first survey conducted after students learned data, the a value was 25.016 and the b value was 0.256. In the second survey, the a value was 23.009 and the b value was 0.275. In the third survey, the a value was 18.237 and the b value was 0.330. The results show that language competence has positive effects on programming interests, and the effect range is 0.254~0.330. The regression analysis findings of the first survey are listed in Figure 1, while those of the second survey are presented in Figure 2, and those of the third survey are shown in Figure 3.

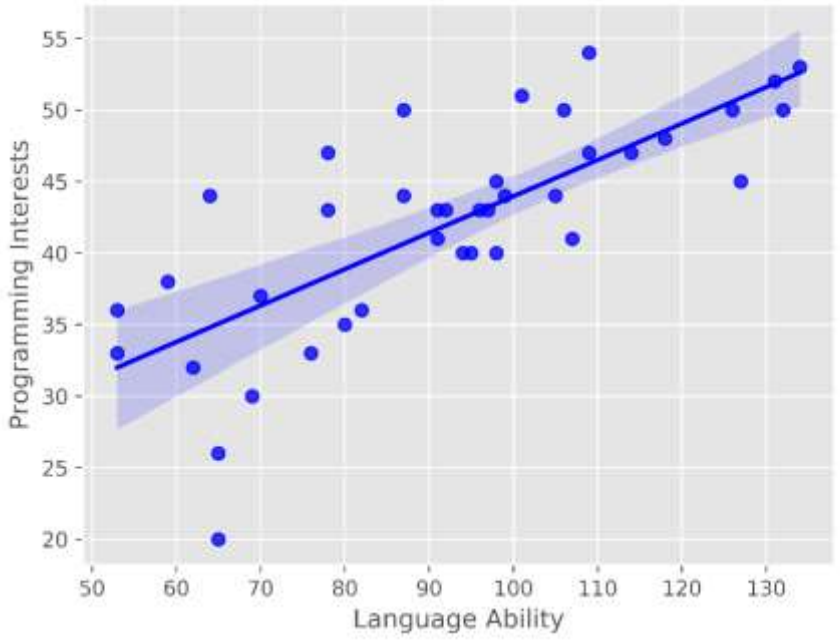

Figure 1: Scatter Plot of Total Language Competence and Programming Interest after first survey

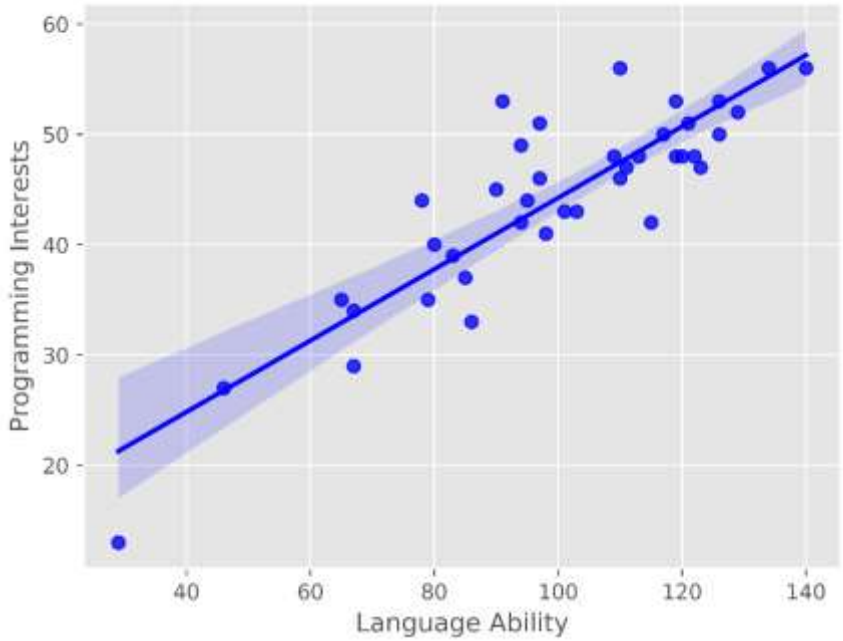

Figure 2: Scatter Plot of Total Language Competence and Programming Interest after second survey

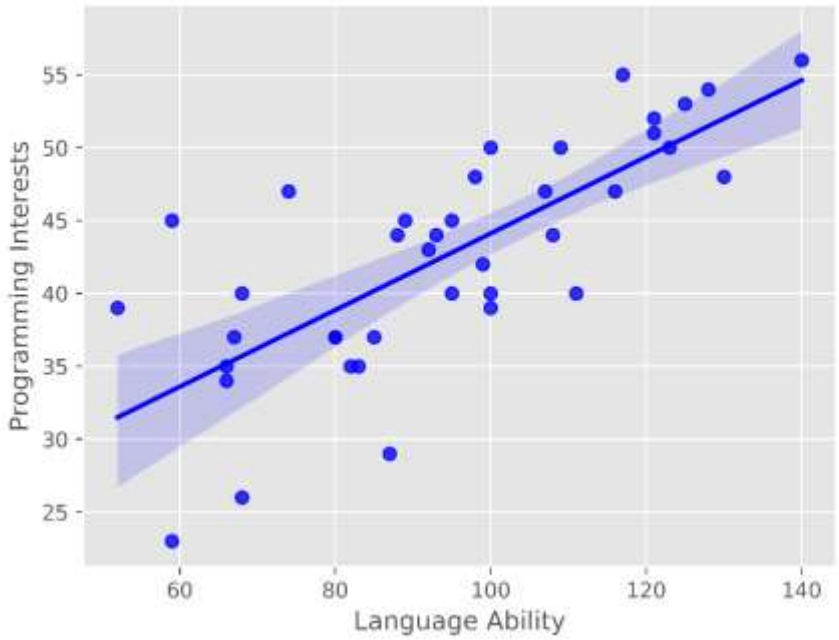

Figure 3: Scatter Plot of Total Language Competence and Programming Interest after third survey

The R_squared values for the first, second, and third surveys were .530, .564, and .747, respectively. The performance evaluation results showed that the mean squared errors for the first, second, and third surveys were 30.924, 30.645, and 22.069, respectively. Finally, the RMSE errors for the first, second, and third surveys were 5.561, 5.536, and 4.698, respectively.

Conclusions

The programming process is a very complicated cognitive process requiring comprehensive thinking. To

ensure that programming beginners maintain interest in programming and participate in the programming learning process, one needs to identify how various types of abilities affect the process.

This study chose 39 college students who had begun to study programming, and measured the effect of computer language competence on their programming interests. This work proceeded by classifying language competence into reading, writing, and grammatical understanding, and identifying whether it is possible to apply operational definitions constituting language competence in programming.

The analysis showed that the lack of sufficient related studies necessitates further research on the operational definitions of language competence in programming. This study classified programming interests into situational interest, latent interest, and actualized interest, and reliability tests of the question items showed that such classification is meaningful. In the case of studies on interest, it was possible to apply an operational definition of programming interests due to existing papers on general interest in learning. While all the question items on knowledge about interest were found to be reliable, additional studies to analyze the relationship between question items are considered to be necessary.

In the correlation analysis between language competence and interest, correlations between the three groups on language competence and another three groups on programming interests were all significant. The effect of language competence on programming interest was found to increase with time. For programming beginners, the effect of language competence on programming interest was in the range of 0.254~0.330, which means that language competence is an important factor in computer programming learning.

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