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Abstract. *The purpose of this research is to compare the previous stereotypes of the scientist image and the current stereotypes of the inventor image among Korean students. For this purpose, three primary schools located in the metropolitan area of Korea were selected under a convenience sampling method, with one class selected for each of the 2nd, 4th, and 6th grades of each school.*

The conclusions of this research are as follows. First, analyzing students' stereotypes of the inventor image showed that older students had more stereotypes about inventors than younger students did. Second, as a result of analyzing the images according to each indicator, Korean students were found to have stereotypes about the inventor. Third, the symbol of research was expressed together with one of the science-related experiment tool and the making-related experiment tool. Fourth, primary students perceived the inventor as mainly male. Male students mostly drew male inventors and female students mostly drew female inventors.

Based on the conclusions obtained through this research, various educational implications to be reflected in primary technology education were suggested to escape the stereotypes of the inventor's image.

Keywords: *Inventor images, invention education, technology education, science education, South Korea*

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PRIMARY STUDENTS' STEREOTYPIC IMAGE OF INVENTOR IN KOREA

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Introduction

Students' stereotyped or distorted image of a specific occupation has a negative impact on the learning attitude or interest in the related subject. This negative impact is also a factor in the choice of career path in the related field (Jeon, Lee, Hong, 2008; Maoldomhnaigh & Mhaoláin, 1990), and many researchers have sought to identify student-perceived stereotypes of certain jobs. Analyzing the perceived stereotypes and suggesting various educational alternatives that can overcome this stereotype could have a positive effect of strengthening the position of the subject.

For this reason, various studies have been conducted to analyze the image of the scientist perceived by students in the field of science education. Scientist image research had evolved from the early Mead and Metraux (1957) research using open questionnaires to the Draw-A-Scientist Test (DAST) of Chambers (1983). Then, Finson, Beaver, and Cramond (1995) led to the development of the Draw-A-Scientist Test Checklist (DAST-C), which could objectively evaluate the image of the scientist. These were representative studies that suggested the method of analyzing the image of a scientist with a picture and the criteria for evaluating it. Since then, many studies had used their analytical methods or modified versions thereof. Most of the studies analyzed by this method reported that students had stereotypes of the scientist image (Barman, 1999; Bodzin & Gehringer, 2001; Fung, 2002; Jeon et al., 2008; Joo, Kim, Noh, 2008; Ju, Lee, Kim, Lee, 2009; Kim, 2015; Kim, Jang, Jeong, 2002; Ko, Kang, Kang, 2016; Kwon, 2005; Lee, Kim, Ju, Lee, 2009; Lim, Lim, Choi, Yang, 2008; Monhardt, 2003; Quita, 2003; Türkmen, 2008). The stereotypes included lab coat, glasses, beard, gender (male), place (indoors), and Caucasian. In order to overcome these stereotypes, changes in teacher's teaching strategies and items to be revised in textbooks were suggested (Bohrmann & Akerson, 2001; Evans, 1992; Mason, Kahle, Gardner, 1991; She, 1995; Smith & Erb, 1986).



Meanwhile, one of the main features of the Korean primary school curriculum since 2015 has been that the contents of invention education were included (Ministry of Education and Science Technology, 2011). This was because of the social need to cultivate human resources capable of active participation in the knowledge-based society.

In this regard, it is necessary to search for ways to more effectively guide the contents on invention in primary-level technology education. One such way is to grasp the stereotypes of the inventor perceived by students and to overcome those stereotypes. The stereotypes about the inventors that students hold can not only negatively affect interest in the primary technology subject that deals with the contents of inventions, but also have a negative effect on students' motivation to decide a course in the field related to the invention. Therefore, it is necessary to carry out research to understand the stereotypes of the inventor. So far, related research has not been done, except that of Moon (2013). In this research, the image of the inventor was analyzed by the methods of Chambers (1983) and Finson et al. (1995). Through this, various ways to overcome stereotypes of the inventor's image were suggested. The purpose of this research is to compare the image of a typical inventor that a primary student perceives with the image of scientist previously identified. This research suggests educational alternatives to overcome stereotypes of the inventor image held by primary students in connection with technology as a primary school subject. Additionally, educational implications can be gained in Korea's science and technology education field, which includes the contents of invention education. Furthermore, because inventor image research has not been carried out internationally, it can provide the theoretical foundation for researchers to carry out related research.

Theoretical Background

Previous Image of Scientist Analysis Research

The first research on image analysis of the scientist was that by Mead and Metraux (1957). They conducted a survey using an open-ended question about the image of the scientist in high school in the United States. They found that the scientist was stereotyped as wearing a lab coat, wearing glasses, and was a Caucasian with a beard. However, there were problems with the questionnaire because students who were too young had difficulty understanding the content of the question (Newton & Newton, 1992).

These limitations were largely resolved through the subsequent work of Chambers (1983). He developed an innovative method of participants drawing a scientist on a blank sheet and analyzing them to determine the extent of stereotypes, rather than the traditional questionnaire. He analyzed previous research on image of the scientist and found that seven indicators (lab coat, glasses, beard, symbol of research, symbol of knowledge, symbol of technology, related explanation) were selected, and the existence of stereotypes was judged by these indicators. Through this research, it was confirmed that stereotypes about the scientists that existed in the previous studies were the same in his research, and that the stereotypes become stronger as the students get older.

The method of Chambers (1983) was the beginning of the research of image analysis, but there was no way to objectively evaluate it. Therefore, Finson et al. (1995) proposed an analytical method to evaluate the degree of stereotypes objectively and quantitatively. They presented the scientist's image as a picture but presented a checklist for analyzing the picture. Using the seven indicators presented by Chambers (1983) and additional indicators (gender, ethnicity, risk expression, presence of bulb, mystery element representation, secret element representation, and work place), they proposed an evaluation method that assigned scores according to whether these indicators existed or not. They found indicators of high stereotyping (i.e. lab coat, eyeglasses, symbol of research, symbol of knowledge, related explanation, male, Caucasian and indoor laboratory) and low stereotyping (i.e. beard, technology, expression of danger, presence of light bulb, and expression of a secret element). They concluded that the more that indicators of high stereotyping appeared, the greater the stereotyping about scientists among students.

The image analysis methods presented in Chambers (1983) and Finson et al. (1995) have been frequently used in many subsequent image analysis studies. Many researchers analyzed the image of the scientist using those methods or modified versions thereof. For example, in Huber's (1995) research, they added indicators such as "strange hair style", "marvelous smile", and "scar". In the studies by Rubin (2003) and Song and Kim (1999), the addition of "the respected scientist name" indicator was analyzed. In the research by Kim et al. (2002), the analysis was conducted excluding a "racial" indicator, which was less important in Korea. In addition, Fralick, Kearn, Thompson, & Lyons (2009) presented a method of analyzing after drawing scientists and engineers, respectively. This method was also very similar to those of Chambers and Finson et al.



In particular, research on analyzing scientist image has been carried out in Korea. For example, Ko et al. (2016) studied the effects of participation in science camp activities on the image of scientists in middle school students. Kim (2015) conducted a research to identify the effect of experience of life-area on the change of the image of scientist in pre-service primary school teachers. A research by Jung and Kim (2014) identifies images of scientists, engineers, and technicians among primary students in Korea. Choi and Hong (2014) conducted a research to analyze the image of the scientist studying small organisms recognized by primary students.

Through these previous studies, researchers confirmed that many scholars were trying to grasp stereotypes of the scientist image. In particular, it was identified that the Chambers (1983) and Finson et al. (1995) method was to analyze the image of scientist expressed in the picture. This approach has been used in several studies seeking to analyze the scientist image until recently.

Previous Image of Inventor Analysis Research

Scientist image research began in the 1950s and has been performed by researchers from around the world since then (Finson, 2002). On the other hand, there have been no cases of inventor image research except for the research by Moon (2013) in Korea. In some scientist image studies, students perceived the work of a scientist as an inventor (Buldu, 2006; Fort & Varney, 1989), and there was a case in which the experimental tools dealt with by scientists were associated with inventions, such as saws and hammers (Newton & Newton, 1998). However, these were also research carried out from the standpoint of scientist image research. A similar research on the inventor image was conducted by several researchers in Korea (Choi, Lee, Lee, 2009; Jo & Choi, 2009; Kim & Ham, 2016; Moon & Shin, 2013). However, these studies also differed from the image of inventor research in that the students' perception of the invention was confirmed.

Moon (2013), the only research that confirmed the inventor's image, developed instruments such as the Draw an Inventor Test (DIT) and Draw an Inventor Test-Checklist (DIT-C). According to his research, primary students recognized Edison as the most representative inventor, and found that the inventor had stereotypes of external images (lab coat, glasses, and beards) and internal images (high intelligence and active). In addition, the inventor had been working indoors and confirmed stereotypes of using models, machines, and measuring tools.

In the case of scientist image research, stereotypical content has served as a foundation for development of theory through the execution of numerous related studies. On the other hand, research on inventor's image is an early stage in which empirical research has not been done yet. Therefore, it is necessary to carry out research related to various inventors' images.

Methodology of Research

General Background

The purpose of this research is to compare the previous stereotypes of the scientist image and the current stereotypes of the inventor image among Korean students. For this purpose, three primary schools located in the metropolitan area of Korea were selected under a convenience sampling method, with one class was selected for each of the 2nd, 4th, and 6th grades of each school. A total of 180 students were asked to draw an image of an inventor. The images were reviewed during students' individual interviews for additional information. In this study, each image was analyzed using the analysis method suggested by Chambers (1983) and Finson et al. (1995).

Sample Selection

In order to analyze the image of the inventor among primary students, three primary schools in the D metropolitan area of Korea were selected under the convenience sampling method, and the participants of the 2nd, 4th, and 6th grades of these schools (9 classes in total) were studied. The research period was from October 4, 2016, to October 28, 2016, and research collaborators were selected for each school for this research. The researchers commissioned them to identify the inventor image, and they conducted an inventor drawing test for 30 minutes using the creative experiential activity time in classes. In a previous research, students were asked to perform additional interviews on the image; the reason was that students might not be able to express their thoughts with pictures (Barman, 1999; Bohrmann & Akerson, 2001; Boylan, Hill, Wallace, Wheeler, 1992; Finson et al., 1995; Fung, 2002; Mason et al., 1991; Palmer, 1997). Based on these researches, the researchers met each student individually



after school each day and conducted individual interviews. In the present research, the final analysis included 180 students. The characteristics of the subjects were 56 students in the second grade (31.1%), 60 students in the fourth grade (33.3%), and 64 students in the sixth grade (35.6%). Of these, 96 (53.3%) were boys and 84 (46.7%) were girls (see Table 1).

Table 1. Characteristics of research subjects.

	2 grade		4 grade		6 grade		Total	
	N	%	N	%	N	%	N	%
Boy	29	51.8	35	58.3	32	50	96	53.3
Girl	27	48.2	25	41.7	32	50	84	46.7
Total	56	100	60	100	64	100	180	100
%	31.1		33.3		35.6		100.0	

Instrument and Procedures

The researchers modified the instruments and analysis methods of Chambers (1983) and Finson et al. (1995) for the efficient analysis of the students-perceived image of the inventor. The instruments consisted of three major areas. Wherein the first, students could freely draw their inventors based on the research of Chambers (1983). The area was composed of a blank space for drawing and making notes on preparation. The second area was an area where students could check additional information on their picture based on the research by Finson et al. (1995). This area consisted of optional or open questions to identify the inventor's gender, age, experimental tools, and descriptions of inventor's activities. The third area presented a selective questionnaire asking about general characteristics of the student, including gender, grade, etc.

The analytical method used in this research is a partial modification of that used by Finson et al. (1995) to determine whether the students had stereotyped indicators in the inventor image. Among the indicators presented in their research, the 9th "ethnicity" indicator was a necessary indicator in a country composed of several ethnic groups. There was no meaning interpretation of the 11th "presence of bulb" indicator in the previous research. Therefore, the present researchers excluded these indicators. The 15th "middle age" or "old age" indicator did not quantify what was meant by these terms. Thus, the present researchers modified this item and presented different age groups for participants to select from.

The instruments and analytical methods were reviewed by experts for their content validity (one professor in technology education, one professor in science education, two teachers in technology education major, and two teachers in primary education major).

Using this, preliminary surveys were conducted for each class of primary students in grades 2, 4, and 6 at each of the three participating schools. The final questionnaire and analysis criteria were set up to reflect the preliminary survey. The indicators used in this research were as follows.

1. Lab coat (not necessarily white)
2. Glasses
3. Beard
4. Symbol of research
 - 4-1. Science-related experimental tools (beakers, flasks, eyedrops, etc.)
 - 4-2. Making-related experimental tools (hammer, saw, bench, etc.)
5. Symbols of knowledge (books, book cabinets, clipboards, pens in pockets, etc.)
6. Symbols of technology (missiles, computers, robots, etc.)
7. Relevant descriptions (related formulas, classification schemes, "Eureka", etc.)
8. Expression of risk-related elements ("risk", "prohibition", etc.)
9. Expression of mystery-related elements (expressed as crazy or bad persons, like Frankenstein, Dr. Jekyll and Hyde)



10. Expression of secret-related elements ("Do not come in", "First class secret", etc.)
11. Workplace
12. Gender
13. Age (10s, 20s, 30s, 40s, 50s, 60s, 70s)

The researchers met individually with each student who participated in this research in an interview setting. Interviews were performed in a relaxed atmosphere and not distracted by noise or other students. During the interview, the researchers sat next to the students and they responded to the researchers' questions. The interview questions were made as follows with reference to Buldu (2006)'s research.

1. Will you please explain your drawing?
2. What does the inventor do?
3. What is this experimental tool?

Data Analysis

In this research, students' image of the inventor was analyzed by the methods used by Chambers (1983) and Finson et al. (1995). Chambers (1983) analyzed the degree of stereotyping in the image based on how the seven indicators (lab coat, glasses, beard, symbol of research, symbol of knowledge, technology, and related explanation) were expressed. In his research, the degree of stereotyping was determined by the ratio of the total number of the seven indexes to the number of students in each grade from grade 1 to grade 5. The higher the ratio the students had, the higher the stereotyping of the inventor. This analysis method has been applied to various studies (Schibeci & Sorenson, 1983; She, 1995; Sumrall, 1995). In this research, the degree of stereotyping of image was confirmed by grade according to that method.

Since Finson et al. (1995) provided an evaluation criterion (checklist), it was possible to judge the stereotyping of the image more objectively than in the analysis method of Chambers (1983). Finson et al. (1995) used the method of counting the number of each indicator that measured stereotyping in the student's picture of the scientist as frequency and percentage. They judged that the higher the percentage, the higher the stereotyping of the scientist. Their analysis method was used in various studies (Barman, 1999; Bodzin & Gehringer, 2001; Fung, 2002; Kim et al., 2002; Monhardt, 2003; Moseley & Norris, 1999; Quita, 2003; Türkmen, 2008). In this research, researchers also identified the degree of stereotyping in each indicator using their method.

For image analysis, two middle school teachers with doctorates in technology education independently analyzed the inventors' drawings and then coded the results. In the previous study, the inter-rater reliability (IRR) of the coding results was considered to be appropriate if the agreed ratio exceeded 90% (Fralick et al., 2009). The IRR of the coding performed in this study was 93%. The coding results that did not match each other were reviewed and reanalyzed. The coding results were statistically processed using SPSS 21.0, and frequency and percentage values were shown.

Results of the Research

Results Analyzed According to the Method of Chambers (1983)

Table 2 shows the results of analyzing inventor image using the method proposed by Chambers (1983). As a result of this research, 110 indicators were expressed in 56 inventor drawings of the 2nd grade, and the stereotypical ratio was 1.96; 137 indicators were expressed in 60 inventor drawings of 4th grade and the stereotypical ratio was 2.28; and 162 indicators were expressed in 64 inventor drawings of 6th grade and the stereotypical ratio was 2.53. As a result, it can be seen, that the higher the grade of students, the more stereotyping they exhibit. This result can be confirmed in the previous studies that identified stereotyping of the scientist image.



Table 2. Comparison of present findings with stereotyping of the inventor's image analyzed based on the method of Chambers (1983).

	This research			Previous research (Sum of indicators expressed / Number of students)			
	Number of students	Sum of indicators	Sum of indicators Expressed / Number of students	A	B	C	D
Grade 1	-	-	-	0.70	0.30	1.18	0.40
Grade 2	56	110	1.96	1.80	0.40	-	0.60
Grade 3	-	-	-	2.40	1.30	1.64	1.50
Grade 4	60	137	2.28	3.10	1.30	-	1.40
Grade 5	-	-	-	3.20	1.60	1.89	1.60
Grade 6	64	162	2.53	-	2.00	-	1.70
Grade 7	-	-	-	-	3.00	-	2.80
Grade 8	-	-	-	-	-	2.83	-

A. Chambers (1983) B. Schibeci and Sorenson (1983) C. She (1995) D. Sumrall (1995)



Expressed indicators : 1
1. Indoors



Expressed indicators : 5
1. Man 2. Lab coat 3. Beard 4. Symbol of research 5. Indoors

Figure 1: Stereotypes by grade (left: 2nd grade, right: 6th grade).



*Results Analyzed According to the Method of Finson et al. (1995)**Analysis of stereotypes about all indicators*

Table 3 shows the results of the inventor's image analysis using the criteria of Finson et al. (1995). According to Table 3, the stereotyping factors were present in the following order: the inventor's workplace: indoor (72.8%), the symbol of research (71.1%), the inventor's gender: male (68.3%), lab coat (43.4%), symbol of knowledge (23.9%), symbol of technology (22.8%), beard (16.7%), related explanation (12.2%), mysterious factors (10.6%), dangerous factors (3.3%), and secret factors (1.1%). The age of the inventor that students asserted was in the following order: in their 20s (31.7%), in their 30s (27.2%), and in their 40s (11.1%). That is, the percentage of students who think that the inventor is young is high.

In this research, indicators such as work place (indoors), symbol of research, and gender (male), which showed somewhat higher percentages in the inventor's stereotypes, were also found to be higher in the scientist image research. The indicators such as mysterious element expression, risk expression, and secret element expression, which showed somewhat lower percentages in the inventor's stereotypes, were also found to be lower in the scientist image research (see Table 3).



- Expressed indicators: gender (male), glasses, beard, lab coat, in-door, symbol of knowledge, symbol of research
- These indicators were expressed in many students' pictures.
- Expressed indicator: dangerous elements
- This student described the scientist as a lunatic who destroyed the world.
- Dangerous element indicators were not expressed in the pictures of most students.

Figure 2: Indicators with high frequency and low frequency

Table 3. Stereotypes analysis of inventor image analyzed based on the method of Finson et al. (1995). A. Barman (1999) B. Finson et al. (1995) C. Fung (2002) D. Kim et al. (2002) E. Monhardt (2003) F. Türkmen (2008)

Indicators	Item	This research								Previous research (%)											
		Grade 2		Grade 4		Grade 6		Total		A		B		C		D		E		F	
		N	%	N	%	N	%	N	%	Grade 2	Grade 3 to 5	Grade 6 to 8	Grade 8	Grade 2	Grade 4	Grade 6	Grade 5	Grade 4 to 6	Grade 5		
1. Lab coat		21	37.5	29	48.3	28	43.8	78	43.3	29.0	41.0	52.0	72.2	14.3	31.7	28.3	72.2	6.0	46.7		
2. Glasses		20	35.7	17	28.3	30	46.9	67	37.2	17.0	28.0	46.0	61.1	21.4	42.3	46.9	72.2	3.0	30.7		
3. Beard		5	8.9	15	25.0	10	15.6	30	16.7	5.0	9.0	26.0	1.3	8.9	15.4	16.1	38.9	2.0	17.4		
4. Symbol of research		40	71.4	42	70.0	46	71.9	128	71.1	72.0	94.0	84.0	52.7	22.3	38.5	29.2	91.7	29.0	86.1		
5. Symbol of knowledge		10	17.9	11	18.3	22	34.4	43	23.9	19.0	35.0	37.0	43.0	11.6	17.3	13.3	38.9	9.0	51.2		
6. Symbol of technology	Expressed	12	21.4	15	25.0	14	21.9	41	22.8	18.0	15.0	20.0	0.0	14.3	10.6	11.5	41.7	11.0	-		
7. Related expression		2	3.6	8	13.3	12	18.8	22	12.2	2.0	13.0	19.0	66.6	0.0	0.0	3.5	55.6	5.0	33.5		
8. Dangerous elements		1	1.8	2	3.3	3	4.7	6	3.3	10.0	18.0	22.0	0.0	-	-	-	33.3	31.0	1.7		
9. Mysterious elements		9	16.1	3	5.0	7	10.9	19	10.6	8.0	11.0	13.0	11.1	-	-	-	-	6.0	2.5		
10. Secret elements		0	0.0	0	0.0	2	3.1	2	1.1	1.0	3.0	11.0	0.0	-	-	-	19.4	1.0	2.4		
11. Place (indoor)		40	71.4	46	76.7	45	70.3	131	72.8	86.0	88.0	71.0	95.9	-	-	-	86.1	18.0	79.8		
12. Gender (male)		33	58.9	47	78.3	43	67.2	123	68.7	58.0	73.0	75.0	83.1	-	-	-	83.3	47.0	94.1		
13. Age	10s	6	10.7	2	3.3	8	12.5	16	8.9	Middle age / Old age											
	20s	23	41.1	12	20.0	22	34.4	57	31.7	13.0	32.0	38.0	-	-	-	-	44.4	1.0	69.7		
	30s	14	25.0	22	36.7	13	20.3	49	27.2												
	40s	5	8.9	12	20.0	3	4.7	20	11.1												
	50s	2	3.6	5	8.3	6	9.4	13	7.2												
	60s	4	7.1	4	6.7	5	7.8	13	7.2												
	70s	2	3.6	3	5.0	7	10.9	12	6.7												

Further analysis of symbols of research

In the previous research, the symbol of research (experimental tool) was one of the main indicators of the stereotype of the scientist image. In this research, additional analysis of the symbol of the research was carried out, and the stereotypes about it were confirmed. In the preliminary research, students' symbols of research were divided into science-related experimental tools (i.e., flask, test tube, beaker) and making-related experimental tools (i.e., hammer, screwdriver, saw). The symbol of the research was analyzed by these two criteria. Even if different kinds of experimental tools were found in the student drawing, the frequency of each experimental tool was not duplicated and counted. For example, if two puppets, five test tubes, one driver, two saws, and two hammers were depicted in the drawing of student A, each repeated symbol of research, science-related experimental tools, and making-related experimental tools, was counted as one. In addition, the number of each individual experimental tool was counted in the student's drawing. Even if several experimental tools were expressed, they were counted as one.



Table 4. Overall trend in symbols of research.

Indicators	Grade 2		Grade 4		Grade 6		Total	
	N	%	N	%	N	%	N	%
Symbol of research (Science + Making)	40	71.4	42	70.0	46	71.9	128	71.1
Science-related experimental tools	20	35.7	31	51.7	36	57.1	87	48.6
Making-related experimental tools	26	46.4	18	30.0	13	20.3	57	31.7

Table 4 shows the overall tendency of students to represent the symbol of research. According to this, 71.1% of the students expressed experimental tools representing science or making. In detail, 48.6% of students expressed science-related experimental tools, and 31.7% of students expressed making-related experimental tools. The prevalence of science-related experimental tools increased gradually as the grade level got higher, such as second grade (35.7%), fourth grade (51.7%) and sixth grade (57.1%). The prevalence of making-related tools decreased gradually as the grade level got higher, such as second grade (46.4%), fourth grade (30.0%) and sixth grade (20.3%).

Type	Experimental tools	Grade 2	Grade 4	Grade 6	Total	
		N	N	N	N	%
Science related	Flask	18	27	35	81	41.5
	Examiner	2	18	19	39	20.2
	Beaker	4	9	14	27	14.0
	Alcohol lamp	4	1	6	11	5.7
	Pipette	1	1	4	6	3.1
	Microscope	1	2	3	6	3.1
	Mass cylinder	0	3	2	5	2.6
	Magnifying glass	1	3	1	5	2.6
	Pipette	1	1	2	4	2.1
	Syringe	0	0	3	3	1.5
	Chalet	0	1	2	3	1.5
	Scale	0	0	2	2	1.0
	Telescope	0	1	1	2	1.0
	Sum	32	67	94	195	100.0
Making related	Hammer	17	10	5	33	41.2
	Driver	6	3	4	13	16.6
	Saw	1	2	3	6	7.6
	Scissors	3	2	0	5	6.5
	Drill	1	4	0	5	6.5
	Wrench	2	1	1	4	5.1
	Spanner	2	0	2	4	5.1
	Bench	2	0	1	3	3.8
	Knife	2	0	1	3	3.8
	Welding machine	0	0	3	3	3.8
	Sum	36	22	20	80	100.0

Table 5. Additional analysis of symbols in research.

Table 5 shows the trends of the individual experimental tools expressed by students. According to the results, science-related experiment tools were presented in order of flask (41.5%), test tube (20.2%), beaker (14.0%), alcohol lamp (5.7%), pipette (3.1%), and microscopes (3.1%). Making-related experiment tools were presented in order of hammer (41.2%), driver (16.6%), saw (7.6%), scissors (6.5%), and drill (6.5%).

As a result of checking the sum of the frequency of each individual experimental tool for each grade, the incidences of science-related experimental tools were 32 in the second grade, 67 in the fourth grade, and 94 in the sixth grade. The incidences of making-related experimental tools were 36 in the second grade, 22 in the fourth grade, and 20 in the sixth grade. In other words, science-related experimental tools gradually increased as the grade increased, and making-related experimental tools gradually decreased as the grade increased.

Further analysis of the gender of the inventor

In the previous research, the gender of scientist was one of the main indicators for judging stereotypes of scientist image, and in several studies, additional analyses were performed to confirm the gender of scientist according to students' gender. Based on the gender of the student, an additional analysis of the inventor's gender was carried out to determine the gender of the inventor, and the results are shown in Table 6.

Table 6. Further analysis of the gender of the inventor.

Inventor gender	Student gender	Grade 2		Grade 4		Grade 6		Total			
		N	%	N	%	N	%	N	%		
Male inventor	Boy	26	89.7	32	91.4	31	96.9	89	92.7	123	68.7
	Girl	7	25.9	15	60.0	12	37.5	34	41.0		
Female inventor	Boy	3	10.3	3	8.6	1	3.1	7	7.3	56	31.3
	Girl	20	74.1	10	40.0	20	62.5	49	59.0		

As a result of the analysis, 68.7% of the students recognized the inventor as male. According to the gender of the students, 92.7% of male students perceived the inventor as male and 7.3% of male students perceived the inventor as female; 41.0% of female students perceived the inventor as male, and 59.0% of female students perceived the inventor as female.



Most female inventors were drawn by female students.

Figure 3: Female inventor drawn by girl.



Discussion

First, in this research, as a result of stereotype analysis of inventor image by Chambers' (1983) analysis method, it was confirmed that stereotyping increased with grade level. The results of this research are consistent with the results of the previous research (Chambers, 1983) that reported that the stereotypes of scientists gradually increased with age.

According to Chambers (1983), indicator ratios indicating stereotypes of scientist image were low in kindergarten and first grade students but started to increase from the second grade and gradually increased with grade level thereafter. The reason for this was that, in lower grades, students rarely expressed stereotypes because they had few stereotypes about the scientist. However, when students were in higher grades, stereotypes were increasing, and they represented many stereotype-related indicators. The present research also showed that the second-grade primary students expressed stereotyped elements, but the higher the grade, the more the stereotype elements were expressed.

Secondly, as a result of analyzing stereotypes of students' inventor image using the method of Finson et al. (1995), researchers found that there were both high and low indicators of stereotype. Finson et al. (1995) did not explain what frequency or percentage indicates high degree of stereotype. However, studies by Finson et al. (1995) or those using their instruments suggested high degree of stereotypes and low degree of stereotypes (Barman, 1999; Fung, 2002; Kim et al. 2002; Monhardt, 2003; Türkmen, 2008). In particular, when there were many indicators with high degree of stereotypes, they interpreted that students had a stereotypical perception of the scientist. In this research, it was confirmed that the results were very similar to those results of the scientist image research. Therefore, it was judged that primary students in Korea had stereotypical perceptions of the inventor.

Scientist image researchers had suggested that stereotypical images of the scientist could instill false prejudices and misconceptions about the science-related profession. Therefore, they insisted that they should have a way to overcome those stereotypes (Lee et al., 2009; Maoldomhnaigh & Mhaoláin, 1990). They suggested that the students met with scientists in person (Bodzin & Gehringer, 2001; Flick, 1990; Jeon et al., 2008), or that scientists visit the schools and participate in classes (Bohrmann & Akerson, 2001; Buldu, 2006; Kim et al., 2002). If these things were difficult, they suggested the presentation of a video showing the scientist's work (Barman, 1999; Bohrmann & Akerson, 2001). In addition, it was necessary to conduct activities such as analyzing image of the scientist in TV and books, drawing images of the scientist and discussing them, and various manipulation activities to enhance students' interest in science (Mason et al., 1991; Matthews & Davies, 1999).

Korea's primary technology curriculum is a course that actually teaches the contents of invention. Therefore, applying the suggestions in these previous studies will overcome the stereotyping of the inventor. In other words, it is possible to apply an activity in which students visit an inventor in a primary technology class, or to invite an inventor in class and introduce their life. If it is difficult to invite an inventor directly or to observe the place where an inventor works, video data showing the life of an inventor can be utilized. In addition, when learning invention contents, students can consider discussing the image of the inventor, especially analyzing and discussing the image of the inventor in TV and comic books.

On the other hand, the present findings confirmed that the inventor who was recognized by the students was an extremely normal person. This is because, in this research, the mysterious element expression, the secret element expression, and the dangerous element expression are hardly shown in the inventors' pictures of the students. These results are consistent with the findings that students perceived scientists as normal (Barman, 1999). The reason that students had an image of a crazy scientist, a psycho-temperamental scientist, and an anti-socialist scientist was because they portray scientists as abnormal people in TV and film mass media (Mason et al., 1991).

The results of this research imply that today's mass media do not describe the inventor in an abnormal way. There was an animation that introduced the case of a great inventor in the mass media, and the viewing of such an animation positively changed the primary students' attitude to invention (Lee, 2015). Therefore, appropriately using the invention animation for motivating the students is considered a way to cultivate a positive image of the inventor when teaching the invention chapter in the primary technology subject.

In addition, in this research, it was confirmed that a lot of the students projected the inventors as relatively young. In early scientist image studies, students had stereotypes of perceiving scientists as middle-aged or



older (Mead & Metraux, 1957), but relatively recent studies or studies of Korean students recognized scientists as young; thus, the perception of these stereotypes had changed (Barman, 1999; Song & Kim, 1999). This can be interpreted as reflecting the social and cultural background in which many students perceive the inventor as being young, considering the situation where most of the workplaces in Korea have a retirement age of 60.

Third, it was confirmed that science-related experimental tools and production - related experimental tools are represented in the symbol of research. Previous scientist image studies reported that chemical experiment tools such as flasks, beakers, and test tubes were frequently expressed (Finson, 2002; Kwon, 2005; Rubin, 2003; Yoo & Cho, 2012). In this research, the same science-related experimental tools were expressed frequently, especially chemistry-related experiment tools. These results indicated that students tended to perceive the inventor as a scientist. In a previous research analyzing the image of a scientist, on the other hand, students recognized that one of the things scientists work on is inventions (Buldu, 2006; Fort & Varney, 1989).

This means that primary students were not clearly distinguishing between the work of the inventor and the work of the scientist. Especially, as a result of this research, the 6th grade students who took the invention chapter in the primary technology subject had the highest rate of recognizing the inventor's experimental tool as a science-related experimental tool. This means that 6th grade students associated the work of the inventor with science. Even though the invention education was carried out in the primary technology subject, students could not distinguish between the scientist and the inventor. Therefore, future Korean textbooks need a clearer description of what scientists and inventors are doing. Evans (1992) and She (1995) reported that the roles of scientists presented in textbooks and science-related experimental tools affect students' stereotypes about scientists. This means that a way to overcome stereotypes of images in the course of education should be suggested (Barman, 1999). Therefore, in the primary technology textbooks of the future curriculum, it is necessary to select illustrations or photographs that introduce the various activities of the inventor. In addition, various tools used in the invention process should be presented in textbooks.

On the other hand, in this research, researchers confirmed that the symbols of research differ from those presented in previous research on the image of the scientist. In other words, experimental tools such as hammer, screwdriver, and saw were expressed, which were experimental tools analyzed by Moon (2013), who analyzed the inventor's image. This experimental tool was not analyzed in most scientist image studies, except Newton and Newton (1998). Therefore, it can be confirmed that these tools are characteristic tools for analyzing image of inventor.

As a result of this research, it was confirmed that the level of stereotypes expressed in the making-related experimental tools decreased as the grade level increased. The reason for this was identified by interviews: The students were not aware of making-related experimental tools but were strongly aware of the use of science-related experimental tools. This was because of the strong tendency to recognize an inventor as a scientist. Through this research, it was possible to identify the stereotypes of the inventor that the students perceived, but it could be used as an indicator that can distinguish the scientist and the inventor. The research on the image of the inventor is in the early stage. Researchers who are studying the inventor image in the future need to establish the theory of the stereotype of the inventor's image through the progress of the research using the indicators or analysis method used in this research.

Fourth, the gender of the inventor that students' perceived was mainly male. Male students mainly drew male inventors, and female students mostly drew female inventors. In most scientist image studies, students perceived scientists' gender as male (Finson, 2002; Fort & Varney, 1989). According to the sex of the students, male students had a higher rate of drawing male scientists, and female students had a higher rate of drawing female scientists. This research also confirmed the same results as the scientist image studies (Buldu, 2006; Flick, 1990; Fort & Varney, 1989; Fung, 2002; Maoldomhnaigh & Hunt, 1988; Newton & Newton, 1992). Through this, it was confirmed that there was a stereotype that the inventor is a man, and there are many students expressing the gender of the inventor in accordance with their own gender.

Scientist image researchers said that the stereotype of a scientist as a male had a negative impact on girls' career setting in science and technology (Bohrmann & Akerson, 2001; Hammrich, 1997). As a way to overcome these stereotypes of gender, Mason et al. (1991) proposed the use of a teacher intervention program that emphasizes the usefulness of career information and career-related settings. In addition, Bohrmann and Akerson (2001) emphasized the need for special teaching strategies for girls. In order to do this, teachers also need to make various efforts to get rid of the stereotypical image of the inventor. On the other hand, in this research,



there were many students expressing the gender of the inventor in accordance with their own gender. In future studies, it is necessary to carry out research to clarify the reason for this.

Conclusions

The conclusions of this research are as follows. First, Korean students' stereotyping was higher as grade level increased. Second, this research confirms that primary students in Korea have stereotypes about the inventor. Third, it was confirmed that science-related experimental tools and making-related experimental tools are represented together as symbols of research. Fourth, students mainly perceived the inventor as male. Male students mainly drew male inventors, and female students mainly drew female inventors.

Based on the conclusions obtained through this research, the following suggestions are offered. First, teachers need to teach students to move beyond the stereotypical image of the inventor. The stereotypical image of the inventor can be a factor blocking the course of the invention-related field. It is necessary to have the capacity of the teacher to guide the students out of such stereotypes. In order to do this, it is necessary to invite inventors into the classroom, presentation of images related to inventors, discussion of inventor images, and experience-oriented invention lessons when referring to the previous scientist image research.

Second, it is necessary to describe the work or role of the inventor in primary technology textbooks. As a result of this research, the tools used by the inventors represented by the 6th grade students who completed the invention section were mainly chemical experiment tools. This means that, despite the fact that they have completed the invention chapter, students were not able to distinguish between an inventor and a scientist. In the future, it is necessary to clarify the roles of these in primary technology textbooks in the Korean curriculum. It is also necessary to select illustrations or photos to introduce various activities of the inventor, and various tools to be used in the invention should be presented.

Third, teachers who teach inventions in primary technology subjects also need to get rid of their own stereotypes of inventors. This is because it is difficult to expect changes in students' perceptions unless the teacher's perception changes. For this purpose, it is necessary to find a way to teach the preliminary primary school teachers not to have a stereotypical inventor image. In the Invention Teacher Training Program for in-service teachers, the contents of the training should be modified so that teachers can escape the stereotype of the inventor.

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