

# A Consideration on Teaching of Metal Processing in Technical Education

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## 1. ABSTRACT

Several attempts were carried out pedagogically and engineeringly in order to get best effect in teaching of metal processing. Since technical education was chiefly composed of lecture and exercise, it should be planned so as one made the most of another effectively.

Teaching materials, which were closely related to content of lecture, must be selected deliberately. Production of a dustpan, book-ends, glasslike metallic products, a screw driver and a paper weight was suitable as teaching materials in metal working.

Exercise gave students remarkable understanding on learning of metal working as well as acquiring how to use manual tools and machine tools. Exercise immediately after lecture also provided students with outstanding improvement of comprehension of teaching content. Guidance, which informed students that theory and method of metal processing was connected with metallic working products used frequently in life, was required in technical education.

## 2. INTRODUCTION

The purpose of technical education is considered to master technique which enables a person to live and work, acting practically, and making theory and practice one body on understanding fundamental theory. This education gives a person creative power, which devises life technically, and attitude to live with abundantly practical power.<sup>1,2</sup>

In our university, faculty of education, industrial art course, teaching of metal

processing has been carried out to students.<sup>3</sup>

Metal processing was mainly composed of casting,<sup>5</sup> heat treatment, plastic working, welding,<sup>8</sup> sintering and cutting. Content of teaching was decided so as to understand sufficiently metallurgy and metal processing as well as master how to use tools. Coming task was solved by examination of questionnaire on lecture and exercise.

In technical education, generally, content of the learning ranged widely,<sup>2</sup> i.e. electrotechnics, wood processing, mechanical engineering, cultivation, metal processing and teaching method of technical education. Since teaching time was limited, efficient teaching was required in order to increase educational effect.

### 3. EXPERIMENTAL PROCEDURE

The questionnaire on content of teaching of metal processing and student's impression was performed to students, which attended lecture and exercise. While products made by students were also evaluated closely. A few readers guided 9 to 19 students to how to use manual tools and machine tools.

Lecture<sup>4</sup> of industrial materials dealt with ferrous alloys, non-ferrous alloys, non-metallic materials of rubber, wood, plastic, cement and refractory, which were used industrially.

In metal construction method, exercise was also carried out on sharpening of drills and turning tools, how to use a cold chisel, taps and a die, a solder, a micrometer caliper and a vernier caliper, files, a protractor, a pair of compasses, a center punch, a saw for metal, a pair of scissors for metal and turning tools et al.

Exercise was also conducted on making of a dustpan, book-ends, glasslike metallic products, a screw driver and a paper weight by use of manual tools and machine tools.

### 4. EXPERIMENTAL RESULT AND DISCUSSIN

#### 4.1 OUTLINE OF LECTURE AND EXERCISE

An outline of lecture and exercise was shown in Figure 1, and several lectures and exercises relating to metal processing were conducted systematically. After lecture of industrial materials, metal processing and metal construction method finished, exercise of metal working was performed.

Heat treatment and tests of mechanical properties of steels were also carried out. Then, significant affairs, which learned in lecture, were reviewed in a practically mannar by exercise. Reports, which completed content of exercise, presented, and they enabled students to comprehend metal processing deeply.

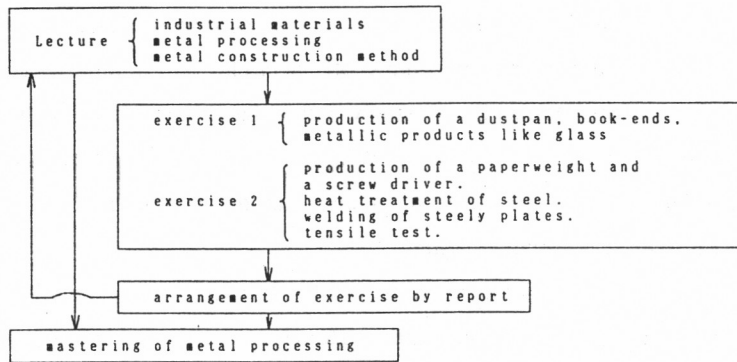


Figure 1 Illustration showing content of lecture and exercise on metal processing

Metal processing was composed of casting, heat treatment, plastic working, welding<sup>8</sup>, sintering and cutting. It occupied an important field of industry and it was situated on working process, which metallic products were made of low materials.

Since metallic processing ranged widely in these large area described above, time of explanation on its content in lecture was apt to be short even for 95 min every week.

Then, introduction of video and slide to lecture and exercise was required in order to enable students to comprehend metal processing swiftly, intelligibly and efficiently.

#### 4.2 LECTURE OF METAL CONSTRUCTION METHOD

The purpose of learning of metal construction method<sup>9</sup> was to make students understand proper use of tools by exercise. Then, name and species of manual tools, outline of the characteristics and how to use them were explained in half time of lecture, and retained time was used for exercise.

Table 1 Order of difficulty of how to use manual tools

order	content	order	content
1	sharpening of drills	7	filing of steely cubic block
2	sharpening of turning tools	8	measurement of angle by a protractor
3	cutting of steely plates by a cold chisel	9	use of a pair of compasses and a center punch
4	working of screw by taps and a die	10	sawing of a steely rod
5	soldering of galvanized iron sheets	11	scissoring of galvanized iron sheet
6	how to use a micrometer caliper and a vernier caliper		

Content of exercise in metal construction method was presented in Table 1. It must be learned to scissor up a galvanized iron sheet, saw a metallic rod, solder galvanized iron sheets, mark off a circle by a pair of compasses, sharpen drills and turning tools, file a steely cubic block and cut steely plates by a cold chisel. Then, use of a micrometer caliper, a vernier caliper and their characteristics were explained. How to use a inside caliper, a outside caliper and a pair of compasses was also made clear.

According to questionnaire, almost all students were bewildered as manual tools gave them rigid impression. However, they were accustomed to deal with tools, as opportunity of exercise increased. Students practiced hardly and almost all of them had a keen interest in how to use tools. Exercise immediately after lecture made students comprehend teaching materials swiftly and intelligibly.

The order of degree of difficulty of how to use each tool in exercise was examined on the basis of questionnaire and the results were presented in Table 1. It was most difficult for students to sharpen drills and turning tools, because it required skill. As shown in Table 1, difficulty of how to use tools became larger in the order of 1. sharpening of drills, 2. sharpening of turning tools, 3. cutting of steely plates by a cold chisel, 4. working of screw by taps and a die, 5. soldering of galvanized iron sheets, 6. how to use a micrometer caliper and a vernier caliper, 7. filing of steely cubic block, 8. measurement of angle by a protractor, 9. use of a pair of compasses and a center punch, 10. sawing of a steely rod and 11. scissoring of galvanized iron sheet.

- Student's impression was summarized as followed after metal construction method.
1. Exercise was effective step to make lecture intelligible, because exercise was learning from experience.
  2. Sharpening of drills was difficult to master, however we were on intimate terms with tools by using them.
  3. We had poor experience in using these tools. We were not only in trouble but also interesting in use of tools during the course of exercise. We would like to use these tools to our heart's content.
  4. As exercise was almost simultaneous with lecture, we could comprehend how to use tools swiftly and intelligibly. Learning from experience built our confidence in metal working.
  5. We were of great absorbing in the teaching.

### 4.3 EXERCISE 1

In exercise 1, a steely dustpan<sup>10,11,12</sup> and steely book-ends<sup>10</sup> were made by use of manual tools. Glasslike metallic products were also done by using a lathe and they were designed by students. A dustpan and book-ends were coated with paint and glasslike products were gilded with nickel after they were worked. The examples of complete works were shown in Figure 2.

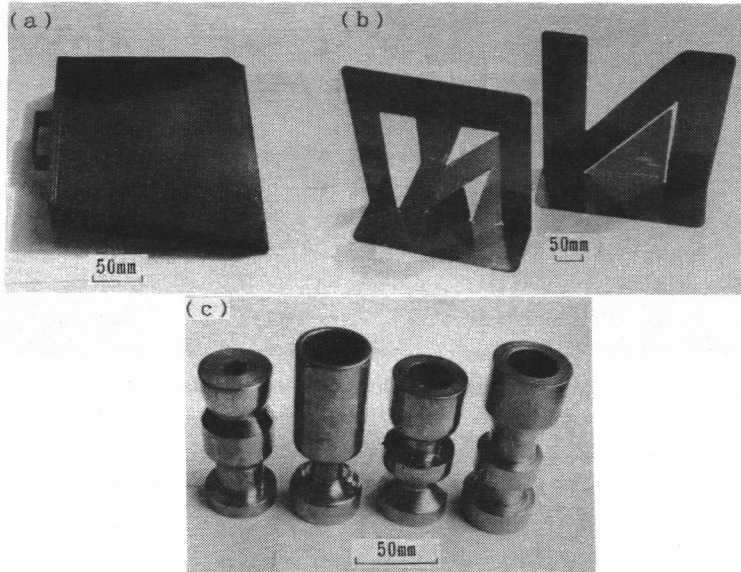


Figure 2 Examples of complete works  
(a) a dust-pan, (b) book-ends, (c) metallic products like glass

Students, which attended exercise 1, had impression as followed after exercise was completed.

1. A dustpan was able to make easily.
2. We could understand effective use of a cold chisel.
3. We were not experienced in operation of lathe. However, we were used to lathe with increase in the frequency of exercise. We were exceedingly interested in continuous change of a rod in shape as a rod was worked by lathe.
4. To acquire how to paint was difficult.
5. Sharpening of turning tools was difficult. It was of use for us to attend the exercise since we took pleasure in making products and acquired how to use tools.

Each process of bending of a dustpan by a wood bar, filing of book-ends, lathing of a steely rod and polishing of book-ends by emery paper was shown in Figure 3 (a),(b),(c) and (d) respectively.

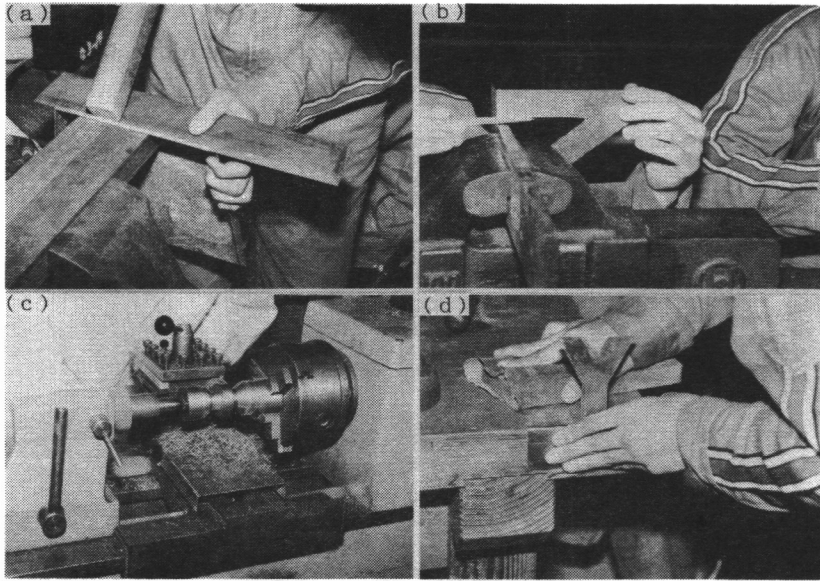


Figure 3 Each process in the course of making products  
 (a) bending of a dust-pan by a wood bar  
 (b) filing of book-ends  
 (c) lathing of a steely rod  
 (d) polishing of book-ends by emery paper

Students practiced hardly. Condition of exercise, which showed filing of book-ends and lathing of a steely rod, was also indicated in Figure 4 (a) and (b) severally.

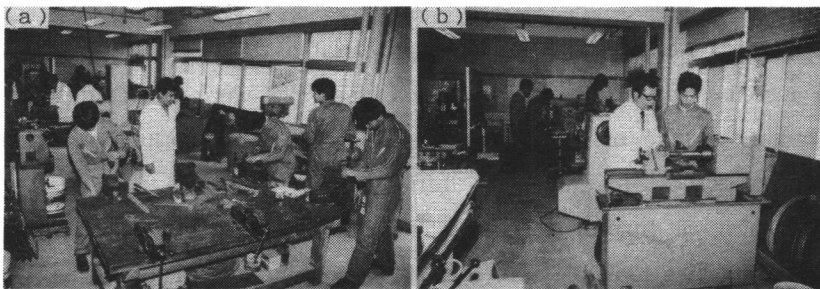


Figure 4 Condition of exercise  
 (a) filing of book-ends, (b) lathing of a steely rod



#### 4.4 EXERCISE 2

Production of a paper weight, a screw driver<sup>13,15</sup>, a hammar, a metallic pen stand and a metallic tape - cutter was also considered to be suitable as teaching materials for exercise.

In this exercise 2, production of a paperweight and a screwdriver was made by use of machine tools<sup>6</sup>, i.e. lathe, milling machine, shaper and drilling machine. The complete paper weights and a screwdriver in exercise 2 were shown in Figure 5 (a) and (b) severally.

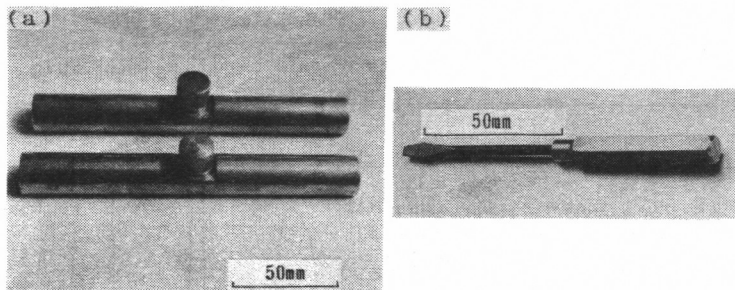


Figure 5 Examples of products made in exercise  
(a) paper-weights, (b) a screwdriver

Then, in order to understand sufficiently joining in metal processing and be informed of mechanical test of metallic materials, welding of steely plates and bending test of them were carried out. The shape of steely plates, the illustration<sup>8</sup> of how to weld and condition of exercise were indicated in Figure 6 (a) and (b) respectively.

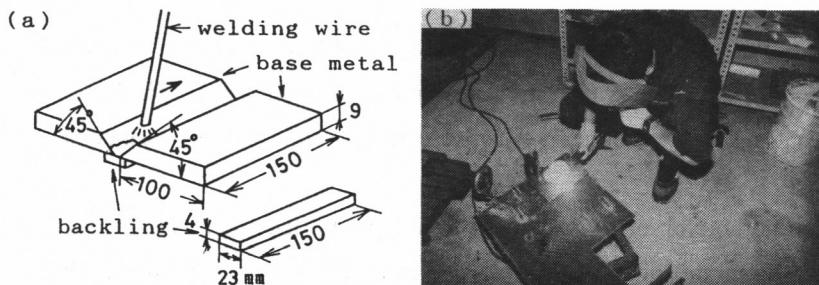


Figure 6 Welding of steely plates  
(a) illustration of how to weld  
(b) condition of welding

In next place, the tensile test of steels was conducted. Effects of carbon content and heat treatment on characteristics of tensile strength<sup>14</sup> was examined. Load - strain curves of steels obtained from this tensile test were shown in Figure 7. Maximum fracture load (P) increased with decrease in tempering temperature and increase in carbon content of steel.

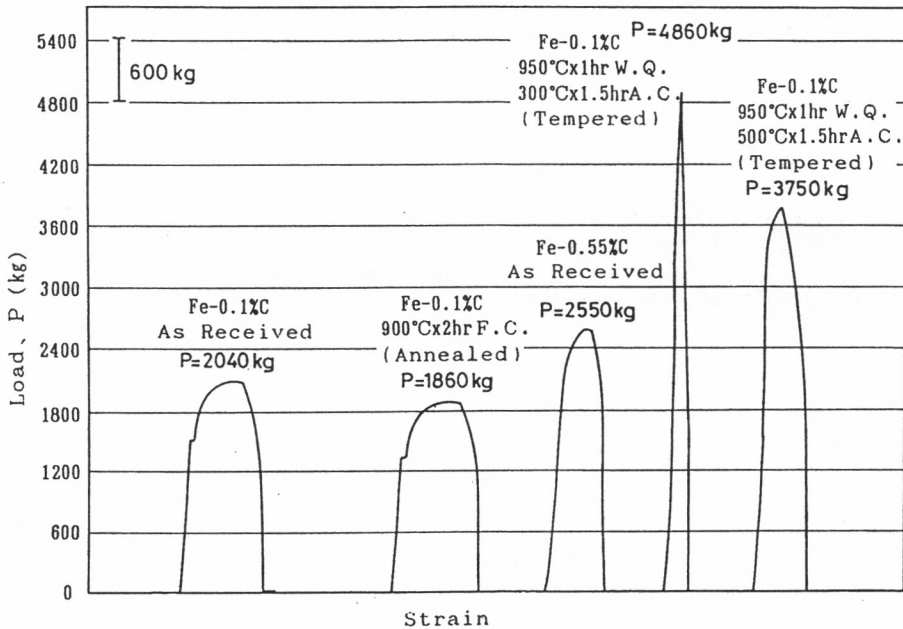


Figure 7 Load - Strain curves of steels obtained from the results of tensile tests.  
(F.C. ; Furnace Cooled, W.Q. ; Water Quenched, A.C. ; Air Cooled)

## 5. CONCLUSION

Reconsideration of lecture and exercise in metal processing of technical education was carried out, referring to questionnaire to students. Then, some problems in teaching of technical education were clarified and guiding principal of teaching was obtained.

Mastering method of metal working and how to use tools in exercise practically as well as learning theory and method in lecture was required in order to understand metal processing. Therefore, main affairs presented in lecture must be adopted as teaching materials of exercise. Almost all students had a keen interest in the subject and large understanding was obtained. Especially, execution immediately after lecture gave students better comprehension of teaching materials.



Furthermore, teaching materials, which lecture and exercise were closely related together, should be selected deliberately.

Introduction of video and slide et al. to lecture was considered to increase interest in learning of technical education.

Recently, ceramic and composite materials were industrially developed as new materials. The characteristics and use of these new materials were explained in lecture. Promotion of exercise containing new materials as instructional materials was supposed to give students more interest in technical education.

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