Establishment the Scoring System of Metalworking Practice Based on “Excellent Engineers Education Training Plan”

Yuan Wang, Wei Li, Yingbiao Wang, Daigen Zhu and Tingting Deng

ABSTRACT

In order to try to fulfill the cores and keystones of the “Excellent engineers education training plan” and the new teaching objectives of Metalworking Practice Course, the scoring system of Metalworking Practice Course was established to restrict the students’ compliance with the relative rules, and to really cultivate their engineering practice ability and innovation ability. The teaching practices have proved that: Firstly the implementation and operation of the scoring system provides an effective support for metalworking practice smoothly carrying out and safely developing, secondly provides a foothold for the "Excellent engineers education training plan" indeed operating and thirdly actively promotes to cultivate students’ engineering practice ability and innovation ability. Moreover, the ideal teaching effect has been achieved.¹

KEY WORDS

Excellent engineers; Metalworking practice; Scoring system; Engineering practice.

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practice effectively [1]. In order to alleviate this phenomenon and improve the quality of engineering education, the Ministry of Education launched the "Excellent engineers education training plan" for higher engineering education in China[2]. The plan, with the background of practical engineering and the main line of engineering technology, aims to improve students' engineering awareness, engineering quality and engineering practice ability through cooperation between school and enterprise. Under the guidance of the plan, the training quality of engineering talents is further raised, and excellent engineers with practical ability and innovative ability are cultivated[3-4]. The core of the plan is to cultivate students' engineering practice ability and innovation ability [5]. The importance of engineering education is emphasized so that students have the quality of engineering ethics and morality[6]. It is helpful for engineering talents to better play their professional competency in the future engineering practice[7].

For a variety of reasons, most Chinese enterprises are reluctant to accept the practice of college students to their units, even if a one-day cognitive visit is also unacceptable to them. Metalworking practice course is one of the most important technical basic courses in the engineering colleges and universities in China. It has many characteristics, such as broad knowledge, great benefit, perfect practice and wonderful innovation. Therefore, it is one of the important teaching links of engineering students' quality training, ability improvement and wide caliber professional education[8]. The teaching goal of traditional metalworking practice course is to "learn technological knowledge, improve practical ability and change the way of thinking[9-10]". According to the actual situation of the development of engineering practice teaching and the training of innovative talents in China, the new teaching goal of metalworking practice course is "learning process knowledge, strengthening engineering practice ability, improving comprehensive quality (including engineering quality), cultivating innovative spirit and innovative ability[11]". It is obvious that the new teaching goal of the metalworking practice course is very consistent with the key of "Excellent engineers education training plan", which emphasizes the cultivation of the engineering practice ability and innovation ability of the college students.

So, metalworking practice course is the key link to the training of students' practical ability and innovation ability for colleges and universities that "school and enterprise cannot unite to cultivate students". How can we guarantee the quality of metalworking practice and how to cultivate students' engineering practice ability and innovation ability in metalworking practice? By summarizing the practice experience of metalworking practice courses for many years, it is found that the establishment of a scientific, reasonable and fair scoring system for metalworking practice is the key and core of ensuring teaching quality and cultivating the students' practical ability and innovation ability. It corrects the improper way that some instructors judge the achievement of practice only on the basis of the results of the students' course examination, and also provides some reference for the score of the follow-up interns.
PRACTICE CONTENT AND SCORING PROPORTION

In our school, the metalworking practice course consists of two parts of the traditional metalworking practice and the modern manufacturing practice. It is listed as two separate courses and arranged in two semesters of sophomore year. Among them, the traditional metalworking practice mainly includes the practice contents of turning, milling, planing, grinding, fitter, casting and welding, and the practice period is 4 weeks, a total of 20 days. The main production is the claw hammer and hammer handle, and the structure and size of the claw hammer are shown in Figure 1. The unmarked fillet is R3mm, the unmarked chamfer is C3mm and the unspecified size tolerance is GB/T1804-c. The material is 45 steel bar of Φ25 mm. Students are required to manufacture according to the regulations, so as to embody the engineering practice ability of students. Hammer handle does not specify specific structure and related dimensions to reflect students' innovative ability. The modern manufacturing practice mainly includes two parts: the numerical control machine and the special manufacture, which are required to be completed within 15 days in 3 weeks. The traditional metalworking practice is the first course of modern manufacturing practice, and it can lay a certain theoretical and practical operation foundation for modern manufacturing practice, so as to guarantee the quality of modern manufacturing practice teaching. Therefore, this article first focuses on the traditional metalworking practice courses to build a scoring system, so that students can grasp the knowledge of common machine tools, traditional crafts and related operations, and then carry out the modern manufacturing practice of the next semester.

According to the time limit and position occupied by each practice work in the process of practice, combining with the students' compliance with the relevant regulations and the performance of innovation ability, the score proportion in the scoring system is set up in Table I, and the percentage system is adopted.

<table>
<thead>
<tr>
<th>Practice work</th>
<th>Turn</th>
<th>Mill</th>
<th>Plan</th>
<th>Grind</th>
<th>Fitter</th>
<th>Cast</th>
<th>Weld</th>
<th>Attendance</th>
<th>Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time /Day</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Score /%</td>
<td>15</td>
<td>12</td>
<td>8</td>
<td>5</td>
<td>15</td>
<td>8</td>
<td>12</td>
<td>5</td>
<td>20</td>
</tr>
</tbody>
</table>

SCORING STANDARD

Content and Score of Attendance

As the saying goes "Nothing can be accomplished without norms or standards". Metalworking practice is basically a student's first entry into the workshop to simulate the construction practice in the factory, so the discipline must be placed
The establishment of relevant scoring standards is a necessary guarantee for students to be disciplined and safety practice conducted.

The attendance score includes three parts: score in late, early retreat and absenteeism, score in compliance with the relevant practice system and score in compliance with practice safety and operation specifications. If the students are late or leave early 1 times, 5 points are deducted; if the students are absent from class 1 times and deduct 10 points, when the cumulative score reaches 30 points, the internship is disqualified and the course is not passed. If the student violates the related system 1 times, deduct 5 points, when accumulates the violation number to achieve 3 times, then cancels the practice qualification, decides that the curriculum fails. Once a student does not follow the safety matters and does not operate the machine tool according to the regulations, a one-vote-down system is adopted.

![Claw Hammer](image1.png)

Figure 1. Claw Hammer.

**Practice Content and Score of Fitter**

The fitter practice is an important part of the metalworking practice. It can not only improve the students' hands-on ability, but also more important to open up the thinking and improve the students' creative ability[12]. In the fitter practice, the main tasks that the students need to complete are: 1) sawing the blanking, the size is Φ25×90mm; 2) drilling the 2×Φ8 mm hole on the claw hammer and file it into R×16.5mm extension hole; 3) scribing and sawing the slant on the claw hammer and obtaining the fillet and chamfering dimensions of R3mm and C3mm respectively.

The score of fitter practice consists of two parts: the practice process score and the finished product score. In view of the standardization and safety of the student's operation in drilling, sawing and filing, the student's practice process score is evaluated, which accounts for 30 of the total score. As long as the students do the practice according to the relevant operational norms, and the number of saw blades broken is less than 1, the full score can be obtained; if the number of the saw blades is larger than 1, the deduction will be 5 points. If a student violates the rules of
operation, he will be deducted 10 points; if he breaks the rules of operation and the number of saw blades broken is greater than 1, he will be reduced by 15 points.

The finished product score is made to evaluate the students' size accuracy of 90±0.3mm, R3mm and C3mm, and the quality of the extension hole. The dimensions of fillet and chamfer are checked by GB/T1804-c, and the tolerances are all ±0.4mm. The scoring in the quality of the extension hole after filing is mainly based on whether the straight line on the extension hole is straight enough, and whether the straight line is tangent to the pre drilling arc at both ends. If the straight line segment is very straight and tangent to the arc, a full score is obtained, more straight and tangent should be buckled 5 points, generally straight and tangent is to be buckled 10 points, straight and tangent or shaped like the "peanut" hole is to be buckled 15 points. For the dimensions of length, fillet and chamfer, 5 points should be deducted for each item exceeding the tolerance ±0.2mm, but the total deduction is not more than 30 points.

**Practice Contents and Scores of Planing, Milling and Grinding**

Planing, milling and grinding are the main teaching contents of mechanical parts in metalworking practice, which mainly cultivate students' ability to operate basic equipment. Through planing and milling, two parallel sides of the claw hammer are machined with a size of 19.2\(^0\)\(^{13}\) mm. The four sides of the claw hammer are processed by flat grinding, and the dimension is 19±0.02 mm. The practice scores of planing, milling and grinding are all made up of two parts, which are 30% internship process and 70% machining dimension accuracy. According to the standard degree of the students' action in operating machine tools, the students' practice processes are scored. The inspection items include the starting and stopping machine tools, the clamping parts, the tool processing and disassembling parts. If the students are able to operate according to the specifications, they can get full marks; if they do not operate according to the specifications without hitting the knife, and 5 points should be removed; if they do not operate according to the specifications with hitting the knife, 10 points are to be removed. The accuracy of machining dimension is scored according to the value of the excess error, and the specific score is shown in Table II. The sizes of the three different parts of the 90 mm length direction on the workpiece are detected. Finally, the average value after three measurements is selected as the final scoring size.

| TABLE II. DIMENSION PRECISION SCORING OF PLANING, MILLING AND GRINDING. |
|-----------------|-----------------|-----------------|-----------------|
| Item           | Planing         | Milling         | Grinding        |
| Error/mm       | <0.05           | 0.05–0.1        | >0.15           |
| Score          | 65              | 60              | 50              |
| Error/mm       | <0.03           | 0.03–0.05       | >0.1           |
| Score          | 65              | 60              | 50              |
| Error/mm       | <0.02           | 0.02–0.04       | >0.06          |
| Score          | 65              | 60              | 50              |

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**Practice Content and Score of Turning**

Turning is an important part of metalworking practice. The time is relatively long, and it is also the starting point for training students to operate machine tools. Turning practice is the most prone to safety accidents in all kinds of practice. It is easy for students to forget the chuck wrench on the spindle and start the machine directly, causing a major accident of personal safety. Therefore, the normalization of the operation and the quality of the work will occupy 50% of the share in the turning practice score. The student got a full mark without hitting the knife in the standard operation, and 10 points should be deducted if he hit the knife lightly, and 20 points should be deducted if he hit the knife badly. If a student does not operate according to the standard, he will fail to pass the whole metalworking practice by one-vote-down system.

After related operations and turning exercises, the students are required to process the stepped shaft with three steps. It mainly checks the control ability of the students to the lathe when they are doing the operation of tool setting and cutting feed. The score of student's turning work will be evaluated by comparing the difference between the step length and the shaft diameter of the stepped shaft with their respective standard sizes. The length of each stepped shaft is 12±0.05 mm, the diameter difference between the segments is 3±0.05 mm, and the minimum diameter is 8 mm. For each length and diameter, if each exceeds the tolerance 0.05mm, then 5 points should be deducted one by one, but the total deduction is not more than 25 points.

**Practice Contents and Scores of Casting and Welding**

Casting practice is complex and requires a long process. It has a complete process requirement, so it can cultivate students' engineering practice ability. The casting practice of our school is carried out by hand casting sand type. The molding, melting, pouring, sand dropping, cleaning and inspection are required for the students to cast aluminum-silicon alloy in two-part molding of wholeness and separation. In the casting practice score, the score of operation process is 40% and the score of casting works is 60%. The operation process score mainly checks the normalization of the students' modeling process and the defects in the cast type. The selection of the collapse box, the caving sand, the gate, the riser or the type surface is unreasonable, and each item should be buckled 5 points. The score of casting works mainly checks the size tolerance of students' casting works, and if each item exceeds the tolerance size, 5 points should be deducted.

The practice of manual electrode welding is the focus of welding practice in colleges and universities, and has laid a foundation for other welding practice teaching. The welding practice of our school is mainly based on manual electrode welding. Before the welding, the students need to complete the work of blanking and component pairs. After completion of the welding, there are also weld cleaning, inspection of weld quality and correction of welding distortion. When scoring the
welding practice, the score of operation process is 60% and the score of welding works is 40%. In order to evaluate the students' mastery of manual electrode welding operation skills, the score of the operation process is mainly evaluated from three aspects of the standardization of the students' welding operation, the frequency of arc drawing, the frequency of arc breaking in the welding process of a welding rod, and the scoring standard is shown in Table III. The welding score mainly evaluates three defects, such as the weld beading and undercut caused by student operation, whether the position of the weld and part is relocated and lack of penetration. If one defect occurs, 5 points will be removed.

<table>
<thead>
<tr>
<th>Frequency of arc drawing</th>
<th>Deduction</th>
<th>Frequency of arc breaking</th>
<th>Deduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1~2</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3~4</td>
<td>5</td>
<td>2~3</td>
<td>5</td>
</tr>
<tr>
<td>&gt;4</td>
<td>10</td>
<td>&gt;3</td>
<td>10</td>
</tr>
</tbody>
</table>

Content and Score of Innovation

Cultivating students' innovative ability is the core issue of the "Excellent engineers education training plan" and the new teaching objectives of metalworking practice course. Therefore, in the metalworking practice organized by our school, the innovative practice link has been specially arranged. In this link, the students use a steel bar with a diameter of 5mm to weld their own creative works, and then to turn the hammer handle which is designed differently from the normal. In the evaluation of innovation, in addition to checking the quality of the two innovative works, the connotation and creativity of the two innovative works will be evaluated comprehensively. For good quality and innovative works, give 90-100 points; more innovative works, give 75-90 points; general innovative, give 60-75 points. For poor quality, but innovative, give 80-90 points; general innovative, give 60-80 points.

SUMMARY OF TEACHING EFFECT

At the start of the practice, first of all, the practice content, the main points and the standard should be explained to the students; Secondly, the discipline and safety precautions should be emphasized; finally, the practice scoring system should be introduced. In the past 5 years, the teaching practice has proved that the scoring system not only constrains the students to abide by the relevant regulations of practice, provides a guarantee for the smooth development and the safety of practice. Moreover, the practical ability of the students' engineering practice has been trained in practice so that they have established the relation between the processing methods and the dimensional tolerance and the tolerance of the shape and position. In addition, it also stimulated students' creativity. To sum up, the implementation of the
scoring system has made a satisfactory teaching effect on the metalworking practice course, and actively promoted the running of the "Excellent engineers education training plan".

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