

Mapping of Psychomotor Skills in Automotive Technology in Malaysian Vocational College Curriculum: A Preliminary Study

*Nadia Ab Latib**, *Adnan Ahmad*

Faculty of Education
Universiti Teknologi Malaysia, Malaysia

**Corresponding author: nadia.latib@yahoo.com*

ABSTRACT

Hands-on training is important in vocational education. Through the concept of learning by doing, students' skills can be developed, improved and applied in the real professional working world. The learning process involves three overlapping domains — cognitive, affective and psychomotor. However, students' ability to perform various practical tasks is related to the psychomotor domain. Hence, this article discussed the psychomotor competency of the students in the automotive course in Malaysian vocational colleges. The psychomotor domain of the Bloom Taxonomy was adopted in this study. This case study involved document analysis on the psychomotor domain mapping with the module of Manual Transmission in Automotive Technology program. Two experts were selected to confirm the psychomotor levels proposed by the researchers for learning outcomes in Manual Transmission course module. The results show that the psychomotor skills levels can be determined for Manual Transmission course in the vocational college's curriculum. Analyses were conducted for each psychomotor level with detailed example for activities in that level. The preliminary findings are proposed to be applied in teaching and learning processes in automotive courses to enhance students' competency in their practical skills.

Keywords: Psychomotor domain, automotive technology, practical training and skills, vocational colleges, Malaysia

INTRODUCTION

Malaysia is a developing country with industrial sector as the core of its national development. In order to fulfil the industrial needs, the vocational education and training system has undergone significant transformation in order to produce adequate skilled labor. One of the vocational transformation initiatives is to adopt new approaches to address the rapid technological changes (Ministry of Education, 2011). The effect of globalization on human resource development is unprecedented. Future workers should be prepared to learn new technology used in the industry. Hence, vocational school curriculum should be assessed and the skills be mapped to predict future competencies. In vocational setting, students are expected to perform tasks involving knowledge, skills and attitudes in order to solve specific problem. To produce skilled workers, students or apprentices are expected to pass the highest level of competency in their specific area of expertise. To be competent, the students need to master the skills. Skill is a psychomotor domain that has several levels. Skills development or capacity building also depends on the effective ways in teaching and learning in skills training institutions.

The vocational lecturers or instructors in vocational education should emphasize on building the students' knowledge and skills (Adnan et al., 2012; Ministry of Education, 2011). Relevant

knowledge and skills are needed for vocational graduates to gain employment (Abd Baser et al., 2013). Hence, appropriate teaching and learning vocational knowledge and skills is required. In learning, some taxonomies of learning schemes have been developed to address three overlapping domains: cognitive, affective, and psychomotor (Rovai, Wighting, Baker, & Grooms, 2009). However, the practical skills of students are closely related to the psychomotor domain (Azri, Awaluddin, & Morina, 2014; Dobbins, 1999; Kamilah et al., 2012).

In automotive course, the psychomotor is the main domain as compared to the cognitive and affective domains. This is due to the involvement of hands-on activities in majority of the teaching and learning processes. In Malaysian vocational college's automotive modules, lecturers agreed that Manual Drive Train Module (MTA 401) is the most difficult subject due to its complexity. Students need to accomplish all the competencies in 14 weeks where the weekly duration is only three hours per week. Furthermore, seventy percent (70%) of the assessments are skilled-based in the psychomotor domain. This clearly shows that psychomotor domain should be emphasized in teaching and learning automotive courses. Furthermore, the lecturers or instructors should know the levels of psychomotor tasks in the module. The mapping of the levels is critical so that the lecturers could plan appropriate teaching and learning strategies on how to deliver the skills to the students effectively.

THE PURPOSE AND OBJECTIVES OF THE STUDY

The purpose of the study was to map the psychomotor skills in an automotive course. Specifically, the objectives of the study are as follows:

- (a) to review the curriculum of manual drive train in an automotive technology program
- (b) to determine the levels of psychomotor tasks in an automotive course

LITERATURE REVIEW

Previous studies on vocational colleges showed that there were some elements or methods that can be applied in teaching automotive courses. Adnan and Nadia (2015) have divided the teaching and learning into three parts: introduction, during teaching session and conclusion. In addition, they also examined the methods for overall teaching in automotive. The parts are as follows:

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|-------|--------------------------|-----------------------------------------|
| (i) | Introduction: | demonstration and questioning technique |
| (ii) | During teaching session: | group monitoring and problem solving |
| (iii) | Conclusion: | re-explaining and report writing |

Generally, automotive course in vocational college focused on developing skills that is psychomotor domain. However, previous researchers have conducted the skills assessment in general without focusing on psychomotor levels. Due to the complains from automotive employers regarding the competency of automotive graduates, it is critical to map the psychomotor levels of the students. Thus, for vocational lecturers, setting practical skills learning outcomes or psychomotor skill levels are becoming vital as the efficiencies of students will be evaluated by their performances (Azri et al., 2014). Ferris and Aziz (2005) have developed new levels of psychomotor domain that are suitable for practical learning. They proposed seven levels of psychomotor domain such as (a) recognition of tools and materials, (b) handling of tools and materials, (c) basic operation of tools, (d) competent operation of tools, (e) expert operation of tools, (f) planning of work operations, and (g) evaluations of outputs and improvement. The psychomotor levels proposed are more suitable to be applied in teaching automotive courses as the elements were explained in details from the perspective of engineering education view (Kamilah et al., 2012; Azri et al., 2014). Therefore, the first step in this research was to review the curriculum of automotive course before categorizing into different levels of psychomotor domain.

Psychomotor Domain

Psychomotor domain is one of the components in Bloom Taxonomy that is used for categorizing the manual competence of individuals (Maidatulakmal, 2012). Psychomotor refers to skill-based tasks that require manual manipulation of objects and physical activities (Rovai et al., 2009). However, the human mind and body will work together while doing the physical activities. Generally, practical skills involved the use of psychomotor domain (Azri et al., 2014; Ferris & Aziz, 2005). Table 1 shows the detail psychomotor levels proposed by Ferris and Aziz (2005).

Table 1: Psychomotor domain level

No.	Psychomotor level	Description
1	Recognition of tools and materials	<ul style="list-style-type: none"> Ability to recognize the tools of the trade and the materials.
2	Handling of tools and materials	<ul style="list-style-type: none"> Ability to handle (pick, move and set down) the tools and materials Ability to handle objects without damage to either the object or other objects in its environment or hazard to any person.
3	Basic operation of tools	<ul style="list-style-type: none"> Ability to perform the elementary, specific detail tasks such as to hold the tool appropriately for use, to set the tool in action.
4	Competent operation of tools	<ul style="list-style-type: none"> Ability to fluently use the tools for performing a range of tasks of the kind for which the tools were designed.
5	Expert operation of tools	<ul style="list-style-type: none"> Ability to use tools rapidly, efficiently, effectively and safety to perform work tasks on regular basis.
6	Planning of work operations	<ul style="list-style-type: none"> Ability to take a specification of a work output required and performs the necessary transformation of description of the finished outcome into a sequence of tasks that need to be performed.
7	Evaluations of outputs and improvement	<ul style="list-style-type: none"> Able to evaluate a finished output product and able to indicate that the quality of the product. Ability to determine particular deficiencies and the actions that could be taken to correct the faults and to make appropriate improvement.

(Source: Ferris & Aziz, 2005)

Vocational College Automotive Curriculum

In vocational colleges, lecturers used Vocational College Standard Curriculum as their reference in teaching and learning. One of the difficult courses in Automotive Technology is Manual Drive Train in which the syllabus needs to be covered in 14 weeks. The course information for Manual Drive Train Module in Vocational College is as shown in Table 2.

Table 2: The course information for manual drive train module

No.	Course content	Learning Outcomes
1	Replace clutch cable	i. Distinguish location of clutch cable ii. Remove clutch cable iii. Change clutch cable
2	Rectify hydraulic clutch system	i. Distinguish hydraulic clutch system components ii. Remove clutch assembly iii. Change clutch assembly
3	Rectify clutch assembly	i. Remove transmission from vehicle ii. Remove clutch assembly iii. Examine clutch assembly iv. Assemble clutch assembly v. Install transmission in vehicle
4	Rectify drive shaft assembly	i. Distinguish drive shaft location ii. Distinguish drive shaft location iii. Change drive shaft dust cover iv. Install drive shaft
5	Rectify propeller shaft assembly	i. Distinguish propeller shaft location ii. Remove propeller shaft iii. Examine propeller shaft universal joint iv. Install propeller shaft
6	Rectify half shaft assembly	i. Distinguish half shaft location ii. Remove half shaft assembly iii. Examine half shaft iv. Install half shaft
7	Service gear shift linkages	i. Distinguish gear shift linkages location ii. Remove gear shift linkages iii. Examine gear shift linkages iv. Install gear shift linkages
8	Carry out front wheel driveshaft rectification work	i. Carry out front wheel driveshaft rectification work ii. Remove front wheel driveshaft iii. Dismantle outer / inner constant- velocity (CV) joint iv. Assemble outer / inner constant-velocity (CV) joint
9	Carry out manual transaxle overhaul	i. Drain transaxle oil ii. Remove transaxle from engine iii. Dismantle transaxle component parts iv. Assemble transmission component parts v. Mount transaxle to engine vi. Fill up transaxle oil
10	Carry out manual transmission overhaul	i. Drain transmission oil ii. Remove transmission from engine iii. Dismantle transmission component parts iv. Assemble transmission component parts v. Mount transmission to engine vi. Fill up transmission oil

No.	Course content	Learning Outcomes
11	Carry out rear axle overhaul 1	i. Identify rear wheel drive shaft location
		ii. Remove rear wheel driveshaft
		iii. Replace driveshaft center - support bearing
		iv. Dismantle driveshaft joint
		v. Assemble driveshaft join
		vi. Install rear wheel driveshaft
12	Carry out rear axle overhaul 2	i. Identify rear axle location
		ii. Remove rear wheel differential unit
		iii. Remove crown wheel and pinion
		iv. Disassemble rear wheel differential unit
		v. Assemble rear wheel differential unit
		vi. Install crown wheel and pinion
		vii. Install rear axle differential unit
		viii. Execute crown and pinion adjustment
		ix. Fill rear wheel axle oil

Currently, there are 12 contents or competencies in this module. Each of the contents has its own learning standards. Students who enrolled in this course are expected to perform in all competencies by the end of semester four. The course is created to ensure that the students acquired the appropriate skills and are prepared before entering their real working life in automotive technology. Since this automotive course involves many practical skills, psychomotor levels play an important role in mapping the skills. For the purpose of this article, only one module was discussed because this module is considered “difficult” by the majority of the students and it involves complex practical skills that is why it is critical to map the relevant psychomotor levels in this module.

METHODS

Document analysis is a systematic procedure that requires the data to be examined in order to acquire proper understanding and to develop empirical knowledge (Bowen, 2009). This approach was employed in collecting and analyzing data in this study. Manual Drive Train module was critically analyzed and the levels of psychomotor in the module were identified based on the framework by Ferris and Aziz (2005). Two expert panels with automotive background were chosen based on their skill certifications and experiences in teaching automotive courses. The experts were able to check and verify the mapping of psychomotor levels in the module. The first expert panel is from the Youth and Sports Skills Institute who has had 12 years of experiences in teaching automotive courses and also have a Diploma in Mechanical Engineering. The second expert panel is a lecturer in Segamat Vocational College who has a Degree in Automotive with 23 years of experience in teaching automotive course. Both experts have qualification in Malaysia Skill Advance Diploma. The followings are the steps in document analysis: (i) analyze the syllabus of manual drive train, (ii) determine the psychomotor levels, (iii) obtain experts verification, and (iv) summarize the results.

FINDINGS AND DISCUSSIONS

This section discussed about the preliminary findings through mapping between the learning outcomes of Manual Drive Train Module and level of psychomotor domain proposed by Ferris and Aziz (2005). There were seven (7) levels of psychomotor included in this study: recognition of tools and material, handling of tools and materials, basic operation of tools, competent operation of tools, expert operation of tools, planning of work operations, and evaluations of outputs and planning means for improvement. Table 3 shows the summary of mapping results.

Table 3: Learning outcomes for manual drive train module and psychomotor levels

No.	Learning Outcomes	Psychomotor Level
1	Distinguish location of clutch cable	1
2	Remove clutch cable	2
3	Change clutch cable	2
4	Distinguish hydraulic clutch system components	3
5	Remove clutch assembly	4
6	Change clutch assembly	5
7	Remove transmission from vehicle	5
8	Examine clutch assembly	6
9	Assemble clutch assembly	6
10	Install transmission in vehicle	7
11	Distinguish drive shaft location	1
12	Remove drive shaft assembly	2
13	Change drive shaft dust cover	2
14	Install drive shaft	7
15	Distinguish propeller shaft location	1
16	Remove propeller shaft	3
17	Examine propeller shaft universal joint	7
18	Install propeller shaft	7
19	Distinguish half shaft location	1
20	Remove half shaft assembly	4
21	Examine half shaft	2
22	Install half shaft	6
23	Distinguish gear shift linkages location	1
24	Remove gear shift linkages	2
25	Examine gear shift linkages	2
26	Install gear shift linkages	6
27	Carry out front wheel driveshaft rectification work	7
28	Carry out manual transaxle overhaul	7
29	Carry out manual transmission overhaul	7
30	Carry out rear wheel driveshaft rectification work	7
31	Carry out rear axle overhaul	7

Based on the empirical results, seven levels of psychomotor domain were found to be useful in mapping the learning outcomes of manual drive train module in automotive program. The discussion for this section is not focusing on every learning outcome but is based on the psychomotor level with the work in clutch system only. The explanations for the results are as follows:

Recognition of tools and materials

The example of the simplest task in this module is that students need to distinguish the location of clutch cable. This is the first level in psychomotor domain that requires students to recognize tools and materials used in automotive courses. The first level of psychomotor only involved with perception that used sensory cues to guide motor activity. In this level, students need to define types, functions, constructions and operations of the clutch system. They also need to locate clutch cable according to the service manual. Task in this level is considered as an introduction about what they need to know in manual transmission system.

Handling of tools and materials

For the second level which is handling tools and materials, expert panels agreed that task such as remove clutch cable suitable for this level. Hence, students activities for this level including demonstrating procedures of detach and removing clutch cable according to the clutch service manual. For this activity, students must be able to handle objects or components without damage to others.

Basic operation of tools

Example for this level is distinguishing hydraulic clutch system components. Based on Ferris and Aziz (2005), students in this level must be able to perform the elementary and specific detail tasks. The criteria for the task include: (a) the functions of hydraulic clutch system according to the clutch fundamentals, (b) interpret the function of hydraulic clutch system according to the clutch fundamentals, and (c) identify the layout and the location of hydraulic clutch system components according to the vehicle service manual.

Competent operation of tools

This level requires students to use tools effectively in specific detailed task (Ferris & Aziz, 2005) such as removing clutch assembly. Activities in this intermediate stage start to include complex movement. Stimuli become common practices and can be done with confidence and competence. Below are some activities for removing clutch assembly: (a) identify types and functions of clutch system according to the clutch system fundamentals, (b) define constructions and operations of clutch system according to the clutch system fundamental, (c) adjust clutch free play and fixing clutch assembly procedures according to the service and repair manual, and (d) dismantle clutch assembly procedures according to service and repair manual.

Expert operation of tools

The fifth level requires students to use tools rapidly, efficiently, effectively and safety to perform work tasks on regular basis. Remove transmission from vehicle is the example learning outcomes for this level. Achievement motor activity for this level involved complex movement patterns which need to be practiced regularly. In this level, students need to accomplish these tasks: (a) identify types of transmission according to the fundamentals of the service and repair manual, (b) identify the location of transmission according to the service and repair manual, and (c) perform detach and removing transmission assembly procedures according to service and repair manual.

Planning of work operations

Example learning outcomes for this level is to examine clutch assembly which is more complex than the previous level. Ferris and Aziz (2005) stated that in this level, students must be able to take a specification of work output required and performs the necessary transformation of description of the finished outcome into a sequence of tasks that need to be performed. Criteria need to be performed by students for this level include: (a) identify types and function of clutch disc according to the fundamental of the clutch system, (b) describe constructions and operations of clutch disc according to the fundamental of the clutch system, (c) identify types and function of pressure plate according to the fundamental of the clutch system, (d) determine construction and operation of pressure plate according to the fundamental of the clutch system, (e) identify types and functions of clutch release bearing according to the service and repair manual, (f) check friction disc facing wear and run-out according to the service and repair manual, (g) check pressure plate wear, scoring, and warping according to the service and repair manual, (h) check clutch release bearing condition according to the service and repair manual, (i) measure flywheel surface run-out according to the service and repair manual, and (j) check pilot bearing condition according to the service and repair manual.

Evaluations of outputs and improvement

Finally, the most complex task is in this level which required student to perform complex task and to evaluate their product for improvement. In order to carry out manual transmission overhaul is the example for the hardest level in psychomotor which requires students to use the skills from the beginning. If they fail to perform certain previous levels, they will not pass or competent to do this task. Moreover, at this highest level, student needs to diagnose if the components fail to function

properly. This level includes: (a) identify location of transmission oil drain plug according to the manufacturer specifications, (b) empty transmission oil and dispose off transmission used oil according to the environmental and safety act, (c) determine the type of transmission according to the vehicle manual drive train fundamental, (d) explain the purpose of and operation of transmission according to the vehicle manual drive train fundamental, (e) describe transmission gear ratio according to the vehicle manual drive train fundamental, (f) detach drive shafts according to the vehicle manual drive train service and repair manual, (g) detach transmission from engine according to the vehicle manual drive train service and repair manual, (h) adhere to the safety rules and regulations, (i) describe the construction of transmission according to the vehicle manual drive train fundamental, (j) explain the operation of transmission component parts according to the vehicle manual drive train fundamental, (k) detach all transmission component part according to the vehicle manual drive train service and repair manual, (l) interpret transmission technical specification according to the service and repair manual, (m) determine condition of transmission component parts according to the service and repair manual, (n) attach all transmission component parts according to the service and repair manual, (o) adjust input shaft front bearing end play according to the service and repair manual specifications, (p) adjust output shaft front bearing end play according to the service and repair manual specifications, (q) adjust output shaft rear bearing end play according to the service and repair manual specifications, (r) fit transmission oil seals according to the service and repair manual specifications, (s) tighten all bolts and nuts according to the service and repair manual specifications, (t) attach transmission to engine according to the service and repair manual, (u) attach drive shaft to transmission according to the service and repair manual, (v) tighten all transmission bolts and nuts according to the service and repair manual specifications, (w) explain type and grade of oil used according to the service and repair manual specifications, (x) pour transmission oil according to the service and repair manual specifications, and (y) check for oil leak according to the service and repair manual.

CONCLUSION

This article reported the outcome of an empirical analysis of the manual drive train module in automotive technology program. The study has identified and map the seven levels of psychomotor skills in this module. The main result of the study shows that the mapping of psychomotor levels was created in this module to facilitate and evaluate learning of psychomotor tasks. In addition, for automotive course in vocational colleges, students are being trained to master the highest level of automotive skills. Mapping the psychomotor levels based on the psychomotor skills learning outcomes is very important because the learners' competencies would be evaluated as strict as in the real workplace. In order to produce high skilled workers for automotive industry, this mapping system for psychomotor domain in automotive technology course is useful.

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