

The development of an inventory to assess the problem-solving attitude of industrial high school students

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ABSTRACT: While facing the present economic society condition that is full of extensive and innovative knowledge, it is paramount for educators to foster students' problem-solving competences through teaching activities and create a cooperative learning environment as well. Therefore, the purpose of this study is to develop an inventory of the problem-solving attitude based on the previous literature and extant questionnaire samples. The effective data was drawn from 185 students recruited from the pre-test conducted at an industrial high school in Taiwan. The data analysis methods included literature analysis, content validity, factor analysis, Pearson correlation and reliability analysis. The Problem Solving Attitude Inventory (PSAI) comprised four factors, ie problem-solving confidence, personal control, approach/avoidance style and problem-solving tendency. The coefficient of Cronbach's alpha was 0.89 for the PSAI (18 items). The factor analysis of the total variance explained was 52.5%.

INTRODUCTION

The objectives of technology-based vocational education are to foster vocational ethics, teach basic professional knowledge and train students to become professional basic-level workers. Therefore, technology-based vocational education is supposed to educate students to achieve two aspects of professional abilities. One is to equip vocational school students with the basic abilities requested by the industry field in terms of technological and practical skills. Students with these abilities would effectively contribute themselves to work and serve as the cornerstone of the industry. The other is to enable vocational school students to possess innovative thinking and problem-solving competences – which cannot be ignored – while these students are educated so that they can adjust themselves to the present social needs and become members of the modern workforce.

When facing the current changes and rapidly moving society, vocational school students have to possess not only specialised knowledge and skills, but also creative and problem-solving competences so as to meet the demands of the present society. Due to the pressures of global competition, the prerequisite of Taiwanese vocational education lies in promoting the nation's status quo by cultivating the required workforce so that they have the following skills on:

- How to reflect;
- How to be creative;
- How to solve problems.

Problem-solving situations surround people's daily lives. It is an interconnected process from encountering and thinking problems to finally solving problems. Involved in such a diverse environment that is blooming with multifaceted knowledge and information, the purpose of education is not only to instil in students the amount of

knowledge required but, most importantly, to recognise students' attitudes towards facing problems. Another purpose of education today is to foster students' competences regarding how to collect, analyse, determine, integrate and apply information [1].

Teachers play a role as the helmsman (*scaffolder*) of school activities and students' learning achievements. Hence, it is considerably important for teachers to be aware of students' problem-solving attitudes so as to effectively cultivate students' problem-solving competences during their classroom instruction.

In view of the above research motivations, in this study, the authors attempt to develop inventories for problem-solving attitudes that are appropriate to the current technology-based vocational education system.

THE PROBLEM-SOLVING ATTITUDE

Problem-solving uses problem space to explain the problem-solving process [2]. This is an application of skills following an individual's experience and knowledge to search for reasonable and appropriate methods to solve cases based on particular problems [3][4].

Problem-solving is the knowledge that solvers retrieve from procedural or declarative memory by which solvers can apply analysis skills, inferential skills, as well as selection and appraisal procedures, or produce feasible strategies to obtain answers to certain problems [5]. It is the knowledge, skills and understanding obtained individually before their application so as to satisfy the demands of new situations that emerge in the problem-solving process [6].

Heppner and Peterson categorised three kinds of attitude towards problem-solving, specifically:

- Problem-solving confidence: whether one possesses confidence when faced with problems;
- Approach/avoidance style: applying an initiative approach or avoidance strategies when faced with problems;
- Personal control: whether or not one puts into practice after well-organised design when faced with problems [7].

Wang pointed out that there are four types of problem-solving attitudes, namely:

- Problem-solving confidence: possessing problem-solving confidence when faced with problems individually;
- Problem-solving tendency: being able to solve problems through thinking, setting objectives, envisaging various ideas, and considering consequences when faced with problems individually;
- Helpless feeling: feeling helpless or having the feeling of no other alternatives when faced with problems individually;
- Personal control: having adequate personal control before making any decisions, rather than making impulsive decisions when faced with problems individually [8].

Lee indicated three types of attitudes involved in the problem-solving process as follows:

- Cognitive ability style: individual recognition and understanding when solving problems;
- Avoidance style: unwillingness to face problem-solving situations when solving individual problems;
- Self-confidence style: individual degree of confidence when solving problems [9].

Lu considered that a complete problem-solving process involved recognition, emotions and action. Therefore, the problem-solving attitudes are distinguished into the following four types:

- Recognition style: recognition and understanding expressed in problem-solving knowledge and individual problem-solving, including the recognition of problem-solving knowledge and recognition of carrying out problem-solving knowledge;
- Avoidance style: avoidance, an unwillingness to face situations with negative sentiments and a tendency to avoid problems;
- Personal control: control of self-thinking, feelings and behaviour when solving problems;
- Self-confidence style: possessing confidence when solving problems [10].

As shown in the above literature review, researchers and scholars have all considered that the problem-solving attitude includes individual points of view in relation to the problem itself, their personal feelings, or their recognition of the problems and solution methods when individually facing problems.

RESEARCH METHODOLOGY

In this study, the authors aimed to develop the problem-solving attitude of industrial school students. The authors chose industrial high school students in Taiwan as the targets, based on the above relevant literature as the theoretical framework of the study. An inventory was used as the tool for measuring reliability.

Sample

An effective sample (185) of industrial high school students in Taiwan, who were invited to participate in this study. The effective sample chosen for this study included 142 male students and 43 female students.

Inventory Process

The inventory of the Problem Solving Attitude Inventory (PSAI) was revised from Lui and Mayer, and Caruso and Salovey [11][12]. It consisted of 36 items in total. The Likert 5-rating scale was used for data collection: strongly agree, agree, sometimes agree or sometimes disagree, disagree and strongly disagree. The scores were assigned as 5, 4, 3, 2 and 1, respectively. The reversed scores were treated as the opposite items. The more that participants possessed the positive attitudes sought, the higher the scale's scores would be.

Content Validity

In order to ensure sufficient content coverage, a table of specifications for the PSAI was constructed and a further validation of its contents was obtained to review and revise it through consultations with three subject matter experts.

Pre-Test Implementation

Students attending National Taichung Industrial High School in Taiwan were randomly sampled. In total, the inventory included a cover letter and a stamped envelope was mailed out to 238 samples on 15 October 2006. The returned questionnaires numbered 213 and the effective data was 185, yielding a usable return rate of 78%.

Item Analysis

An item analysis was undertaken of the valid questionnaires for data coding, reverse questions re-coding points, and then calculated for the total score. The pre-27% were arranged as the high score group while the post-27% were set as the low score group. According to the level of demand, the item analysis was based on averages and a t-test below the 0.05 level of significance was deleted. Additionally, in order to calculate each critical ratio of items, if the critical ratio value of the items was below the significance level ($p < 0.05$), the items could be identified from the reactions of different subjects, judging whether the items were deleted as a principle so that there was no discrimination.

Furthermore, the Pearson correlation coefficient was another chosen standard. The study deleted the correlation coefficient, which was below 0.25. Both of them were indeed statistically significant for every item. The results showed that the number of compatible items in the PSAI was 22.

Validity Analysis

A validity analysis measures the level of mental or behavioural characteristics through testing. Apart from the content validity, after the study utilised an item analysis to identify the main items, the authors also used a factor analysis in order to establish validity. Those items whose commonalities had Eigen values greater than one were retained. Orthogonal rotation (oblique rotation) axis was achieved by utilising the Varimax method [13].

According to KMO and Bartlett's method test and the principal factors factor analysis, the results showed that Kaiser-Meyer-Chi-Square Test measure of sampling adequacy was 0.88 in the PSAI. This indicated the suitability of the factor analysis. In addition, the Bartlett ball test from the chi-square test of the value was found to be significant ($p < 0.00$). This was representative of the correlation matrix between the population groups and carried communality.

Formal Inventory

In order to increase the level of reliability, Cronbach's alpha values were improved. After completing the formal questionnaire preparations, a reliability analysis was conducted using Cronbach's internal consistency method. Among them, factor 6 of the PSAI was deleted for poor internal consistency because of only one item, and factor 5 was deleted as well due to the low Cronbach's alpha value. Hence, after analysis, the final four factors were extracted. The total Cronbach's alpha equalled 0.89 and the items equalled 18. After this process, the instrument validity was checked by three experts to examine systematically the given content and those factors named, ie problem-solving confidence, personal control, approach/avoidance style and problem-solving tendency. These factors could be explained from 52.5% of the total variance. The reversed scores were treated as the opposite items (6 and 13).

In order to calculate further the correlation between the quantity scale and total scale, the homogeneity of the contents of the questionnaire was verified. The Pearson correlation coefficient was subsequently estimated to indicate a positive and modest correlation and the scores of every factor were determined. The correlation coefficient was from $r = +0.37$ to $r = +0.82$ in the PSAI. This correlation is statistically significant at the 5% level of significance. Among them, every factor was found to indeed be statistically significant.

CONCLUSION

To sum up, the inventory (shown in Table 1) used a five-point Likert's scale. In view of the above significant statistics, the study indicated that the PSAI could serve as a reference point for educators to investigate students' problem-solving attitudes so as to discover further whether students possessed problem-solving competences.

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Table 1: The Problem Solving Attitude Inventory (PSAI).

[Instructions]:					
Please indicate your response to the questions with the number that most closely matches your points of view. 1= strongly disagree, 2= disagree, 3= sometimes agree or sometimes disagree, 4= agree, 5= strongly agree. You have to answer every question, do not omit. Thank you for your cooperation.					
Items	1	2	3	4	5
<i>Problem-Solving Confidence</i>					
1. When I am faced with problems, I think I can handle them smoothly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. I'm still confident that I am competent enough to solve problems by myself.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. I am confident to solve problems which cannot be solved by classmates.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. I am confident that I will be able to come up with innovative and effective methods to solve problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. I am confident that I can solve most of the problem, when given abundant time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. I often feel depressed with my problem-solving methods.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Personal Control</i>					
7. After solving problems, my expected results are compatible with the real results.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. When faced with a difficult problem, I often calmly deliberate on problem-solving methods.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Once I figure out the problem solving methods, I am clear about the next problem-solving step.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. When investigating problems, I often could control the central issues.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. Before solving problems, I could make efforts to understand the key points.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Approach/Avoidance Style</i>					
12. When faced with a problem, I will deliberate on the next problem-solving step.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. When faced with a problem, I often adopt an avoidance attitude.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. I will review the causes for which I cannot solve a problem smoothly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. When faced with a problem, I would examine the consequences of different solving methods and then make a final decision.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<i>Problem-Solving Tendency</i>					
16. When I am faced with problems, I would ask others for help.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. When I am faced with a problem, I try my best to find different problem-solving methods to solve the problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. When faced with a problem, I will search for external resources to solve the problems.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The end of the questions. Please check again, to see if you missed some questions. Thank you.					

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