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# Modification and Validation of a Questionnaire for Measuring the Psychological Capital of Engineering Students

An Jie Lye[a], Hidayah Mohd Fadzil[b], Chan Choong Foong[c], Peng Yen Liew[d,*]

[a]Institute for Advanced Studies (IAS), Universiti Malaya, 50603 Kuala Lumpur, Malaysia
[b]Department of Mathematics and Science Education, Faculty of Education, Universiti Malaya, 50603 Kuala Lumpur, Malaysia
[c]Medical Education and Research Development Unit (MERDU), Faculty of Medicine, Universiti Malaya, 50603 Kuala Lumpur, Malaysia
[d]Department of Chemical and Environmental Engineering, Malaysia-Japan International Institute of Technology (MJIIT), Universiti Teknologi Malaysia, 54100 Kuala Lumpur, Malaysia
pyliew@utm.my

Psychological capital refers to an individual's self-perceived positive psychological state of development. As engineering is always full of challenges and obstacles, it is important to develop the psychological capital of engineering students to make engineering a sustainable career. However, existing instruments are developed in non-engineering contexts. This study selected, modified, and validated an existing instrument to provide accurate measurements for engineering students. The Psychological Capital Questionnaire (PCQ) was modified and validated in two phases. In the first phase, six experts, including chemical engineers, chemical engineering educators, and lecturers in education were recruited for the content validation to review the items. Two items with a content validity index (I-CVI) less than 0.78 were revised based on the suggestions, and the experts revalidated modified items. After the second review round, all items' I-CVI were acceptable. In the second phase, cognitive interviews were carried out with five engineering students. The modified questionnaire was presented to the interviewees to seek their feedback on the clarity of items. Based on students' feedback, items were modified and finalised when no new suggestions were given. Flesch reading ease score was calculated, and it was found that the language in the modified questionnaire could be easily understood. As a research outcome, the modified PCQ is ready to be used among engineering students in the future.

## 1. Introduction

The Fourth Industrial Revolution (IR 4.0) has tremendously contributed to the sustainable development of the economy, environment, and society (Jayashree et al., 2022). The revolution depends on the connectivity between humans and technology (Laurent and Fabiano, 2022); therefore, it is essential to cultivate a dynamic workforce that can address the needs of industries. In the digital revolution, future engineers must possess professional knowledge and skills and be resilient to adapt and learn fast in solving different challenges (Jumari et al. 2017). Therefore, engineering education should emphasise the development of students' mental health to prepare them for the challenging working environment (Danowitz and Beddoes, 2022).

Psychological capital is important to maintain the mental health of students. It refers to an individual's self-perceived positive psychological state of development (Luthans et al., 2012). It consists of four elements: self-efficacy, hope, resilience, and optimism (Luthans et al., 2012). Interpreting Luthans' work, engineering students with high self-efficacy are confident to accept and resolve challenges in their studies. With the presence of hope, engineering students are perseverant towards goals and redirect their paths to goals whenever necessary in achieving success. Meanwhile, engineering students with good resilience can sustain and bounce back when they face a failure or difficulty. Finally, optimistic engineering students always believe in accomplishing great achievements in the present and the future.

Past studies have shown that psychological capital positively correlates to motivation, well-being, and performance. For instance, Rabenu et al. (2017) reported a strong positive correlation between psychological

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capital, well-being, and performance. Similarly, Luthans et al. (2012) also found a significant positive relationship between psychological capital and academic performance. As engineering is always full of challenges and obstacles, it is important to develop the psychological capital of engineering students to make engineering a sustainable career for them. Therefore, an instrument that can accurately measure engineering students' psychological capital is needed. However, current evaluations of psychological capital depend on the questionnaires validated in non-engineering contexts, such as workers in general (Cid et al., 2020), undergraduate students in general (Kang et al., 2021), and patients with Parkinson's Disease (McDaniels et al., 2022). Hence, this study aims to modify and validate an instrument for measuring the psychological capital of engineering students. In the following sections, instruments and modifications, methodology, results, discussions, and conclusions will be presented. This study would contribute by producing a modified instrument for measuring the psychological capital of engineering students.

## 2. Instruments and modifications

Methods presented in this study are part of more extensive research investigating the non-cognitive abilities of engineering students. Psychological Capital Questionnaire (PCQ) is a common instrument to measure psychological capital. It is first developed by Luthans et al. (2007) to measure the psychological capital of organisation workers. This self-administered questionnaire comprises 24 items (Tables 1-2) with a 6-point Likert scale (e.g., 1 – Strongly Disagree; 6 – Strongly Agree). It is divided into four domains, known as self-efficacy (items 1 to 6), hope (items 7 to 12), resiliency (items 13 to 18), and optimism (items 19 to 24). To suit the engineering context, the authors modified some of the terms in the original questionnaire. For example, the examples listed in item 5 have been changed from 'suppliers, customers' to 'working engineers', and the term 'work goals' has been changed to 'study goals' in item 8 (Table 1).

*Table 1: Original, modified, revised, and finalised items of the Psychological Capital Questionnaire (PCQ)*

| No | Original items (Luthans et al., 2007) | Modified items by the authors | Content validation results | | | Finalised items after cognitive interviews |
|---|---|---|---|---|---|---|
| | | | I-CVI (Round 1) | Revised items | I-CVI (Round 2) | |
| 1 | I feel confident analysing a long-term problem to find a solution. | - | 1.00 | - | 1.00 | - |
| 2 | I feel confident in representing my work area in meetings with management. | I feel confident in presenting my ideas in meetings with lecturers. | 1.00 | - | 1.00 | - |
| 3 | I feel confident contributing to discussions about the organisation's strategy. | I feel confident contributing to discussions about teaching methods. | 0.67 | I feel confident contributing to discussions. | 1.00 | - |
| 4 | I feel confident helping to set targets/goals in my work area. | I feel confident helping to set targets/goals for my learning. | 1.00 | - | 1.00 | - |
| 5 | I feel confident contacting people outside the organisation (e.g., suppliers, customers) to discuss problems. | I feel confident contacting people outside the program (e.g., working engineers) to discuss problems. | 1.00 | - | 1.00 | - |
| 6 | I feel confident presenting information to a group of colleagues. | I feel confident presenting information to a group of peers. | 1.00 | - | 1.00 | - |
| 7 | If I should find myself in a jam at work, I could think of many ways to get out of it. | If I had a problem in my studies, I could think of many ways to solve it. | 1.00 | - | 1.00 | - |
| 8 | At the present time, I am energetically pursuing my work goals. | At the present time, I am energetically pursuing my study goals. | 1.00 | - | 1.00 | - |
| 9 | There are lots of ways around any problem. | There are lots of solutions to any problem. | 1.00 | - | 1.00 | - |
| 10 | Right now I see myself as being pretty successful at work. | Right now, I see myself as being quite successful in my studies. | 0.83 | - | 0.83 | - |

*Table 2: Original, modified, revised, and finalised items of the Psychological Capital Questionnaire (PCQ) (continued from Table 1)*

| No | Original items (Luthans et al., 2007) | Modified items by the authors | Content validation results | | | Finalised items after cognitive interviews |
|---|---|---|---|---|---|---|
| | | | I-CVI (Round 1) | Revised items | I-CVI (Round 2) | |
| 11 | I can think of many ways to reach my current work goals. | I can think of many ways to reach my current study goals. | 1.00 | - | 1.00 | - |
| 12 | At this time, I am meeting the work goals that I have set for myself. | At this time, I am meeting the study goals that I have set for myself. | 1.00 | - | 1.00 | - |
| 13 | When I have a setback at work, I have trouble recovering from it, moving on. | When I have a problem in my studies, I have trouble recovering from it, moving on. | 1.00 | - | 1.00 | - |
| 14 | I usually manage difficulties one way or another at work. | I usually manage difficulties in any way that is possible in my studies. | 1.00 | - | 1.00 | - |
| 15 | I can be "on my own," so to speak, at work if I have to. | I can be "on my own", so to speak, in my studies if I have to. | 0.83 | - | 0.83 | I can be independent in my studies if I have to. |
| 16 | I usually take stressful things at work in stride. | I usually take stressful things in my studies calmly. | 1.00 | - | 1.00 | - |
| 17 | I can get through difficult times at work because I've experienced difficulty before. | I can get through difficult times in my studies because I have experienced difficulties before. | 1.00 | - | 1.00 | - |
| 18 | I feel I can handle many things at a time at this job. | I feel I can handle many things at a time in my studies. | 1.00 | - | 1.00 | - |
| 19 | When things are uncertain for me at work, I usually expect the best. | When things are uncertain for me in my studies, I usually expect the best. | 0.83 | - | 0.83 | - |
| 20 | If something can go wrong for me work-wise, it will. | If something can go wrong for me in my studies, it will go wrong. | 0.83 | - | 0.83 | If I foresee something can go wrong for me in my studies, it will go wrong. |
| 21 | I always look on the bright side of things regarding my job. | I always look on the bright side of things regarding my studies. | 1.00 | - | 1.00 | - |
| 22 | I'm optimistic about what will happen to me in the future as it pertains to work. | I am optimistic about what will happen to me in the future as it relates to my studies. | 0.83 | - | 0.83 | - |
| 23 | In this job, things never work out the way I want them to. | In my studies, things never work out as I wish. | 0.67 | In my studies, things do not go well as I expect. | 1.00 | - |
| 24 | I approach this job as if "every cloud has a silver lining." | I always believe that difficult times always lead to better days. | 0.83 | - | 0.83 | - |
| | | | S-CVI = 0.93 | | S-CVI = 0.96 | |

Note: "-" indicates no change is required, the item is accepted as it is.

## 3. Methodology

This research consists of three parts to validate the Psychological Capital Questionnaire (PCQ) questionnaire for assessing the psychological capital of engineering students: content validation, cognitive interviews, and Flesch reading ease.

### 3.1 Validation method

Content validity is the extent to which the elements of an instrument are relevant and representative of the targeted construct to fulfil a particular assessment purpose (Lynn, 1986). The elements of an instrument refer to the questionnaire items, response formats, and instructions, whereas the construct refers to the domain or variable which is the target of the measurement process (Yusoff, 2019). Therefore, it is crucial to determine the instrument's content validity, such as research questionnaires. Meanwhile, content validity reduces the possible mistakes in administering the questionnaire and rises the possibility of gaining positive construct validity (Shrotryia and Dhanda, 2019).
There are six steps of content validation: (i) designing the content validation form, (ii) recruiting a review panel of experts, (iii) performing content validation, (iv) reviewing domain and items, (v) rating each item, and (vi) determining content validation index (CVI) (Yusoff, 2019).

#### 3.1.1 Designing content validation form

A content validation form was designed to assure that the selected experts would clearly understand the content validation procedure. At the beginning of the form, clear instructions and definitions were stated to help the experts understand their tasks and facilitate the scoring process. The degree of relevance of items was measured with a 4-point Likert scale (e.g., 1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, and 4 = highly relevant) (Yusoff, 2019).

#### 3.1.2 Recruiting a review panel of experts

The review panel of experts was recruited considering their academic qualifications, expertise, and working experience in engineering. The acceptable panel size ranged from six to ten experts (Lynn 1986; Shrotryia and Dhanda, 2019). The authors invited two experts from three different contexts respectively: (a) chemical engineering industries, (b) chemical engineering education, and (c) education – survey research to perform content validation for the modified questionnaire.

#### 3.1.3 Performing content validation

After obtaining their participation consent, the content validation form was sent to the experts via email. Depending on availability, the experts took two to four weeks to complete the content validation form. Reminders were sent if the responses were not obtained.

#### 3.1.4 Reviewing domain and items

The definition of psychological capital was clearly stated in the content validation form. The experts were requested to critically review the domains and items prior to rating each item. In addition, the experts were also requested to write feedback or suggestions to enhance the relevance of items to the domain. The feedback and suggestions given by the experts were considered for the revision of the items.

#### 3.1.5 Rating Each Item

After critically reviewing the domains and items, the experts were requested to rate each item using the relevance scale. The content validation form was returned to the researchers once completed.

#### 3.1.6 Determining content validation index (CVI)

This study calculated CVI for item (I-CVI) and CVI for scale (S-CVI). I-CVI refers to the amount of content which is rated as relevant by experts while S-CVI refers to the average I-CVI scores for all items on the scale rated by experts (Yusoff, 2019). Before calculating the CVI, the relevance rating given by the experts was recorded as 1 (for items rated with a relevance scale of 3 or 4) or 0 (for items rated with a relevance scale of 1 or 2). When there are six or more experts, the CVI values should be at least 0.83 or above for a valid instrument (Lynn, 1986).

### 3.2 Cognitive interview

A cognitive interview is an interdisciplinary combination of survey methodology and cognitive psychology, which can identify potential problems in the development or modification of questionnaires by investigating participants'

cognitive processes in answering questions (Willis, 2015). Think-aloud and verbal probing are techniques that are commonly applied in cognitive interviews.
Before the cognitive interviews, an interview guide with structured probing questions was prepared. For think-aloud, the interviewer read aloud each item, and the participants were encouraged to comment if they had difficulty answering the items. Meanwhile, for verbal probing, the interviewer asked targeted questions and the participants answered them. Then, if more information were required, the interviewer would follow up by asking other probing questions to understand the thinking process of the participants and how they reached their answers (Jia et al., 2022). All the cognitive interviews were conducted individually using Microsoft Teams. Each interview took approximately 90 minutes. After each interview, the questionnaire was modified based on the feedback from the participants before presenting in the following interview.

### 3.3 Flesch reading ease

Flesch reading ease was calculated for the questionnaire. It measures the readability of the text by calculating the average number of the syllabus in a word and the average number of words in a sentence (Chua et al., 2019). In the Flesch reading ease, the text is scored between 1 and 100. A document should have a score between 60 and 70 for standard readability (Chua et al., 2019).

## 4. Results and Discussions

### 4.1 Content validity index

The item-level content validity index (I-CVI) and scale-level content validity index (S-CVI) were calculated based on the data collected during the content validation (refer to Table 1). In the first round of content validation, two items (items 3 and 23) were rated I-CVI of 0.67, below the acceptable level of 0.83 for a panel of six experts (Lynn, 1986). Hence, the items were revised before presenting to the experts for the second round of content validation. For instance, the term 'teaching methods' in item 3 was removed, and item 23 was rephrased as suggested by the experts. After the revision, the I-CVI of these two items increased to 1.00, indicating that all experts had agreed to their relevancy. Meanwhile, the S-CVI was good as it increased from 0.93 to 0.96, indicating that all test items are relevant to the tool.
The content validation results implied that almost all experts unanimously agreed that the items are essential and relevant to the engineering context. The results cohere with the past studies (Aslan Çin et al.,2022; Li et al., 2020) where the items were acceptable if I-CVI > 0.78.

### 4.2 Cognitive interview results

Five engineering students from different gender, races, programmes (including chemical engineering students), universities, and years of studies were recruited for the individual cognitive interviews to ensure the generalisability of the results. As mentioned in the previous section, the questionnaire was modified based on participants' feedback between interviews. For example, the term 'on my own' was replaced by 'independent' in item 15 and the term 'foresee' was added in item 20 to make it more straightforward. The revised questionnaire was tested in the following interview until no further problem was identified (in the fifth round) (Tse et al., 2020). All participants agreed that all test items were clear and easy to respond to. Meanwhile, the items were important and meaningful to them as engineering students. They also confirmed the clarity of instructions and format of the questionnaire. Finalised items are shown in Table 1.

### 4.3 Flesch reading ease results

The Flesch reading ease score of the modified PCQ was 68.3. Meanwhile, the average number of syllables per word was 1.5, and the average number of words per sentence was 11.5. The result is similar to the result (Flesch reading ease score 71.3) reported by Pugh et al. (2018) in their studies. In an ideal situation, an instrument should demonstrate a Flesch reading ease score between 60 to 70 to be easily comprehended by 7$^{th}$-grade students (Chua et al., 2019).

### 4.4 Strengths and limitations of the study

To the authors' best knowledge, this was the first study of questionnaire modification that included content validations, cognitive interviews, and the Flesch reading ease score in a single study in the engineering context. A search in the Scopus and Web of Science databases using the keywords – questionnaire, content validation, cognitive interview, Flesch reading ease, and engineering students returned no results. Therefore, it is suggested that future engineering studies adopt these systematic approaches to validate their newly designed or modified questionnaires to ensure the relevancy and readability of the instruments.
This study has limitations as it has not collected actual responses using the modified questionnaire. Construct validation should be performed after respondents' data is collected in future research. Future studies could also

adopt this instrument on a wider engineering population in different countries, languages, and cultural contexts for further psychometric validation.

## 5. Conclusions

In conclusion, the modified Psychological Capital Questionnaire (PCQ) is validated using content validation, cognitive interviews, and Flesch reading ease. As a result, it is ready to be used to measure the psychological capital of engineering students.

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