Revista Argentina de Clínica Psicológica
2020, Vol. XXIX, N°5, 574-591
DOI: 10.24205/03276716.2020.1055

Development and Psychometric Properties of the Adversity Quotient Scale: An Analysis using Rasch Model and Confirmatory Factor Analysis

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Abstract

Adversity Quotient (AQ) is a new concept in facing the challenge for success. Previous studies have shown very limited instruments in measuring AQ such as the lack of empirical evidence on psychometric properties for AQ items, especially for testing with different types of statistical testing theory. The overall aim of this paper is to develop and assess the psychometric properties of the AQ items for technical students using the Rasch model and Confirmatory Factor Analysis (CFA). A survey with a quantitative approach was employed to measure the four main constructs of AQ, namely Control, Ownership, Reach, and Endurance, whereby the questionnaires were based on a four-point Likert Scale. The respondents include 1,845 polytechnic students from five polytechnics who were selected using the proportionate clustered multistage stratified sampling technique. The response rate was 97.52 percent with 1,845 returned and usable questionnaires for data analysis from a total of 1,892 questionnaires distributed to the respondents. A two-step procedure involving the Rasch model and confirmatory factor analysis (CFA) was used for the statistical analysis via WINSTEPS 3.71 and AMOS 21 software. The findings indicated that 15 items were statistically proven with good psychometric properties to measure AQ for both analyses. The items also fulfilled all of the main assumptions of Rasch including item fit, unidimensionality, local independence, item polarity, and gender differential item functioning analysis. The measurement model using CFA provided satisfactory model fit of $\chi 2/df$ with 3.874 ($\chi 2= 321.527$, $p<0.05$, $df =83$), RMSEA = 0.039, GFI = 0.977, RMR = 0.013, AGFI = 0.966, CFI = 0.950, TLI = 0.936, and NFI = 0. 933. This instrument can help the stakeholders identify the person with problematic AQ for guidance besides guiding the practitioners to holistically investigate the pattern of AQ. Future researchers can also focus more on the different adversities for the variety group with an emphasis on convergent and discriminant validity as well as qualitative approaches to further explore the adversities. In essence, this paper particularly provides new insights into policymaking and practices improvement for AQ self-development measurement.

Keywords: Adversity Quotient; Instrument; Polytechnic Students; Development; Psychometric.

1. Introduction

The Fourth Industrial Revolution Intelligence Framework concentrates on the ten types of intelligence (Oosthuizen, 2017) such as Contextual Intelligence (CI), Entrepreneurial Intelligence (EntI), Strategic Intelligence (SI), Ecosystem Intelligence (EcoI), and, Ethical Intelligence (EthI). These types of intelligence are applicable for students to develop and apply in order to connect the potential disruption brought by the Industrial Revolution 4.0 (IR 4.0). Most of the students need to get ready in handling IR 4.0 challenges, especially those who are involved in the technical area or Technical and Vocational Education Training (TVET). In the global world, most TVET workers are facing many adversities in their lives and jobs. Future workers may have the skills and knowledge; however, sometimes, they failed to handle the problems and quit the job immediately. Aida Aryani Shahroom and Norhayati Hussin (2018) stated that

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educational institutions need to prepare the competencies for students to be job creators, inventing new technologies, and mitigating new problems that may occur.

A study conducted in Bangladesh reported several IR 4.0 challenges in Bangladesh such as bad infrastructure, cheaper labor rate, and lack of knowledge and government support (Md Asadul Islam et al., 2018). Such adversities need to be overcome by adding some resilience values to our future graduates or essential employability skills of the 21st Century. The final report of the 2017 ATN Learning and Teaching Grant (Brewer et al., 2018) described the need for enhancing the resilience among academics and industrial staff. This shows that future graduates need to have skills on how to handle challenges.

The report by the COMCEC Coordination Office (2018) about the TVET sectors emphasized that apprentices should have the ability to overcome difficulties by thinking (cognitive skills) and dealing with multiple factors (non-cognitive skills). The urgent skills for the TVET sectors for future graduates are needed to analyze and solve complex problems. Research conducted by Azmi, Hashim, and Yusoff (2018) mentioned several gaps in the type of competencies among university students in both public and private institutions. Soft skills such as problem-solving, leadership, and decision-making were highlighted more on the public university students, while analytical skills and language competencies were highlighted more on the private university students. This shows that soft skills are more prepared for public university students and hard skills are more demanded of private university students.

TVET in several Islamic countries (OIC) shows the barriers of insufficient funding for skill training and facilities, especially in the TVET field. The TVET graduates are also not getting proper acknowledgement in society and the workplace unlike the other developed countries such as Australia, and many countries are not able to send their skilled people to foreign countries because of language constraints. This clearly indicates that vocational education is aimed at preparing young people with sufficient knowledge, skills, and attitude to prepare them for the next level as required by the market of other countries (COMCEC Coordination Office, 2018).

In facing the IR 4.0 challenges, the polytechnic is one of the prominent TVET institutions that focuses on its strategic plan to be the leader of IR 4.0 through TVET 4.0 (Ahmad, 2018). Polytechnic Transformation in Malaysia is aimed at developing the skilled workforce for more than 10 percent by 2015 to cater to the industrial demands (The Department of Polytechnic Studies, 2009). Malaysia also requires a resilient, competitive workforce that can adapt to challenges and the ever-changing labor market (Zuhaila Saleh, Mohd Safarin Nordin, & Muhammad Syukri Saud., 2012). As such, the National Education Philosophy (NEP) in Malaysia has listed three dominant types of intelligence for self-development such as intellectual quotient (IQ), emotional quotient (EQ), and spiritual quotient (SQ). Unfortunately, we have witnessed some occasions where brilliant students sometimes failed to cope with adversities. This condition, as mentioned by Stoltz (1997), explains why different persons with the same quality of EQ and IQ react differently to the challenges. This calls for the needs or gaps for us to look into one potential factor called Adversity Quotient (AQ).

Adversity Quotient (AQ) is well-defined as one's capability to face and handle challenges and change it into opportunity in order to succeed (Stoltz, 1997). Adversities can be defined as hardship or misfortune in one's lifetime and they can be categorized into inner and outer adversities. Inner adversity includes uncertainties, depression, anxiety, insomnia, or loneliness, whereas outer adversity considers external factors such as natural disasters, car breakdown, lack of money, computer problems, and failure in exams (Stoltz & Weihenmayer, 2010). All adversities have the potential to affect individual lives. As such, the need for AQ is high for technical students to face adversities adeptly and properly.

Research on AQ is worldwide and recent studies have been conducted across countries such as India, Indonesia, China, the Philippines, and Malaysia (Ahmad Zamri Khairani & Syed Mohammad Syed Abdullah, 2018; Bingquan, Weisheng, Xudong, & Wenxiu, 2019; Darmawan, Budiyono, & Pratiwi, 2019; Kuhon, 2020; Kundan & Sabina, 2019; Mohd Effendi Ewan Mohd Matore, Normawati Abdul Rahman, Hisyamsani Idris, Ahmad Zamri Khairani, & Nurfarzana Mohd Al Hapiz, 2020; Muztaba, Syamsul Bahri, & Farizal, 2019; Rosiqoh, Barus, Bohori, & Suhendi, 2020; Yazon & Ang-manaig, 2019). Some of the studies are related to adversity and other variables with different research contexts (Quas, Dickerson, Matthew, Harron, & Quas, 2017; Solis & Lopez, 2015; Tian & Fan, 2014). The first instrument of AQ or Adversity Response Profile (ARP) developed specifically for workers and organizations was published in the late-1990s (Stoltz, 1997).

The ARP helps organizations measure AQ and

predict success; however, the user had a problem to access to the full version of the instrument. One of the most popular instruments of AQ is Adversity Response Profile (ARP) by Stoltz (1997). Nonetheless, Angelopoulos et al. (2002) had clearly explained the problems that occurred from the ARP such as the reliability and validity aspects that were not demonstrated in detail, insufficient demonstration evidence on psychometric statistical procedures, incomplete data report such as sampling and research procedure, unconvincing instrument development with no rationale and justifications, unclear justifications on the adversity scenario picked for ARP, lack of information on the applications of experts' judgment, and confusing method in terms of how they developed the potential scenarios for measurement. Although statistical empirical evidence on the construct development of AQ is lacking, AQ is, most importantly, always related to challenges faced by individuals. As such, each country is probably facing different unique problems and it is highly unlikely that the individuals will act similarly. There is always an issue with the adaptation of the original instrument, especially with the translation mode. A previous study had also mentioned psychometric issues such as the reliability, validity, and unidimensionality of the items on ARP (Thi, 2007). There are even suggestions that AQ instruments should be developed in more detail, specifically by creating more items to deliver more information about AQ (Khalia Febriyani, 2014).

Subsequently, many of the instruments were developed by the researchers. Such barriers existed when the items went through the process of translation and adaptation into several languages. One of the main limitations demonstrated by previous research is the ambiguity of the adversity measurement when developing the items. Over years, there had been limited attempts to develop the AQ scale (Njoto, 2006; Bingquan & Can-Rui, 2008; Bingquan et al., 2019; Desika Nanda Nurvita, 2011). Unfortunately, the adaptation instrument and items recognized several psychometric barriers such as ununiformed context (Angelopoulos et al., 2002; Anik Budi Utami & Lydia Freyani Hawadi, 2006; Primatika Fatma Rahastyana & Laily Rahmah, 2010), ambiguous context and adversities (Rahmat Aziz, 2008), translation and language problems (Teddy Djuliarki Kurniawan, 2011), and unfairness of the items (Imroatul Hajidah, 2009). The problems worsened when several methodological aspects were involved such as the validity and reliability issues (Bakare, 2015; Kanjanakaroon, 2012; Pasaribu, 2011; Thi, 2007). Consequently, there was a lack of instruments to measure AQ for technical students.

Thus, this study aims to clear the current gap through the development and psychometrics of newly developed items for AQ specifically for technical students. These items with high validity and reliability can be applied to obtain quality AQ items and superior construct understanding, investigate the AQ pattern, conduct self and peer assessment, identify strengths and weaknesses, and improve the testing of items to advance their usability and validity. The information is useful in making meaningful decisions to produce a resilient and competitive workforce.

2. Materials and Methods

2.1. Study design and setting

A quantitative approach of survey research design using paper-and-pencil was applied. The cross-sectional national study involves a sample of polytechnic students in Malaysia. The main idea of this research includes (i) pilot testing, (ii) actual study, and (iii) construct validation using CFA.

2.2. Participants

The sample involves 1,845 polytechnic students from a population of 18,828. The composition includes (i) pilot testing using Rasch (n = 943), (ii) actual study using Rasch (n = 1,845), and (iii) construct validation using CFA (n = 1,845). This study adopted a clustered multistage stratified proportional sampling technique involving five polytechnics according to geographical zones (Northern, Western, Southern, Eastern, and Borneo). The return rate was 97.52% and considered acceptable (Christensen, Johnson, & Turner, 2011; Loewenthal, 2001). The present study was reviewed and approved by the Centre for Research and Development of Polytechnics (PPPP) and Ministry of Higher Education, Putrajaya, Malaysia. The respondents' information is shown in Table 1.

2.3. Item development process

The several models applied include adversities model, content model, statistical model, and instrument development model. The adversities model is based on eleven challenges by Mooney Problem Check List (MPCL) (Mooney & Gordon, 1950), while the content model or the CORE model provides a conceptualization of AQ with four main constructs (Stoltz, 1997). The statistical model analysis employs the Content Validity Ratio (CVR), Rasch Measurement Model (RMM), and Confirmatory Factor Analysis (CFA). The instrument

development was based on nine structured steps proposed by Miller and Lovler's (2015) model as follows: (1) defining instrument universe, target audience, and instrument purpose; (2) developing instrument plan; (3) composing instrument items; (4) writing administration instructions; (5) conducting a pilot study; (6) conducting an item analysis; (7) revising the instrument; (8) validating the instrument; and (9) developing norms. From writing administration instructions (Step 5) to validating the instrument (Step 8), it should be noted that the procedure is conducted repeatedly in order to establish appropriate instructions and items. This paper will cover the steps from number five to number eight only. Based on the instrument development model, the study comprises six (6) important steps, namely (a) adversities identification for getting the list of main adversities, (b) item development by literature review, (c) face validity for getting feedback from the students about the items, (d) experts' judgment for content validity, (e) pilot study for initial reliability and validity, and (f) actual study for final validation and analysis.

2.4 Adversities identification

This study identified 55 main adversities faced by polytechnic students. A total of 52 adversities came from MPCL using logits value by RMM Mohd Effendi Ewan Mohd Matore & Ahmad Zamri Khairani, 2014) and the other three adversities were from open-ended questions that are part of MPCL by using a qualitative analysis (Mohd Effendi Ewan Mohd Matore & Ahmad Zamri Khairani, 2015b).

2.5 Item development

Items were developed based on several challenges by which each of the challenges was expanded and conceptualized into four constructs of AQ, namely Control, Ownership, Reach, and Endurance (CORE model). The CORE model comes from a combination of seven cognitive psychology theories such as (i) Learned Helplessness Theory (Seligman, 1975), (ii) Attributional Theory (Weiner, 1974), (iii) Endurance Theory (Kobasa, 1979), (iv) Resiliency Theory (Grotberg, 1995), (v) Self Efficacy Theory (Bandura, 1977), (vi) Locus Control Theory (Rotter, 1966), and (vii) Optimism Theory (Seligman, 1975) that formed the four main constructs of AQ: Control, Ownership, Reach, and Endurance. At first, almost 55 challenges from the polytechnic students were obtained from the adversities identification phase.

2.6 Conceptualization and operationalization

Subsequently, the main construct of AQ was operationalised properly within the research context. Control I explains how much control an individual perceives to have over an adverse condition (Stoltz, 1997), which seeks to address the question of to what extent does an individual perceive whatever happens next. The word 'perceive' is applied because it is almost difficult to quantify actual control. Furthermore, perceived control is more important since it symbolizes one's willpower in his or her mind to control an adverse condition. Individuals with high Control are capable of controlling and responding well to challenges. They are also often optimistic about life and they can bounce back easily when experiencing failure. Otherwise, individuals with low Control are unable to control their challenges and they often think negatively without a high determination to face challenges in life. Meanwhile, Ownership (O) is related to issues on the origin of adversity, which is mainly concerned about the extent to which one owns the adversity outcomes (Stoltz, 1997). Individuals with high Ownership are able to explain the cause of the problems encountered as well as recognizing the existence of the impacts of these problems. Sometimes, this may lead to self-blame; however, this is actually good to make them more accountable for the challenge. Individuals with low Ownership, on the other hand, will normally have blurred and indistinct interpretation of the cause of the problems. They tend to ignore the potential impact of the problems encountered that, in turn, will lead to chaos.

Reach I measures how well individuals can limit the effects of adversity in their lives (Stoltz, 1997). A person with high Reach is capable of limiting adversity effects to a particular area, while an individual with low Reach may let the adversity to creep further into life. Individuals with high Reach normally ensure that the challenges faced by them will not affect the other sides of their lives. For example, when a student is having problems with their peers, the student is still able to study well and get good results in examinations as the challenge did not affect any other aspects of his or her life. Conversely, a student with low Reach will show his or her weakness and is easily influenced by life challenges and problems. For example, these problems would make students lose their focus besides causing anorexia, illness, academic performance decline, and at worst, suicide. Finally, Endurance I explains the length of the adverse effects (Stoltz, 1997). Individuals with high Endurance are normally enthusiastic and have

confidence that every challenge will finally end (Phoolka & Kaur, 2012). Besides anticipating how long these challenges will last and then perish, they are also able to survive and find a solution to these problems. Individuals with low Endurance will conversely let the challenges continue to plague them without any attempt to address these challenges, which may sustain even longer. Thus, the integration of all CORE constructs is very important to produce individuals with high AQ to strengthen the intelligence model in the National Philosophy of Education in Malaysia.

After completing the conceptualization process, the items were generated by matching the 55 main challenges with the 4 constructs of AQ. This means that one construct of AQ will have 55 items with an overall total of 220 items. Table 2 shows examples of items for each construct.

This model is compatible with the Rasch Measurement Model (RMM) framework, which offers a more precise procedure for the evaluation of instruments such as norms, standards, equality of scores, validity, and reliability (Hambleton & Jones, 1993). At the same time, the RMM instrument development framework does not differ much from the raw-score framework. Both the instrument development models and RMM framework share similar procedure such as the preparation of the instrument specifications, the number of instruments item, item revision study, pilot study, final development of the instruments, administrative instruments, administrative direction and technical manuals, as well as the printing and distribution of instruments and manual (Hambleton & Jones, 1993). In addition, the instrument development model is also widely used in the local context (Rohaya Talib, 2009; Syed Muhd Kamal S.A.Bakar, Ahmad Esa, & Syed Muhamad Dawilah Syed Abdullah, 2014).

2.7 Face validity

Ten students were randomly selected from one polytechnic in the Southern zone through the purposive sampling method to obtain their feedback on the test takers' difficulty and misunderstanding whether from the aspects of clarity of purpose, language, and test duration (Cohen, Swerdlik, & Sturman, 2017). Face validity usually involves an evaluation among those who are not experts (Mukesh Kumar, Salim Abdul Talib, & Ramayah, 2013) and a group of individual test-takers who could importantly provide useful input about the items being tested (Kline, 2005). The Content Validity Ratio (CVR) was conducted quantitatively to test for face validity (Lawshe, 1975). The CVR is useful in consideration of time and cost reduction with easier administration and faster implementation. The research procedure began with a review of the test respondents and followed by experts' judgment. The assessment would test the understanding of the items from the aspect of suitability and the level of language to the element of meeting the content validity.

The respondents were asked to check their understanding of the language and detect if any of the items provide a similar or different meaning to the original context, including the difficulty of the words from the respondents' perspectives. The CVR was applied using a three-point scale (1 – essential, 2 – useful but not essential, and 3 – not necessary). The formula is $CVRi = [n_e – (N/2)] / (N/2)]$, where "$CVR_i$" is the value of the item in the developed test, "ne" is the total number of experts who evaluated the item as essential, and "N" is the total number of expert panels participated in the test. The range of CVR values is within -1 to +1, by which the CVR that is close to +1 indicates that the experts agreed that the item is very important. A total of 33 items from 220 items were required for refinement. For example, item 33 with the words "resigned" or "willing" and item 42 with "determined" and "careless" or "oblivious". Based on the informal interviews with the test-takers, it was found that the word in item 33 was poorly understood by most of the non-Malay test takers. For the Ownership construct, item 60 was deemed difficult with the word "bother". Item 72 also brought confusion to the students' understanding of the meaning of "striving hard" in the context of the sentence. Examples of items in the Reach construct included item 136 with the word "natural" and item 138 with the word "mix", which were poorly understood by the non-Malay test takers. The Endurance construct was rather difficult to understand, such as item 168 with the word "worried" and item 172 with the word "moody", which were to be changed (Mohd Effendi Ewan Mohd Matore & Ahmad Zamri Khairani, 2015c). These items then proceeded to the next step that is experts' judgment.

2.8 Experts' judgment

Using purposive sampling, the total number of experts appointed was 37, which includes 9 professional experts and 28 field experts from ten polytechnics and some of them are lecturers from various departments. The panel of experts was selected based on several criteria such as academic qualifications, publications, and involvement with students and adversities in polytechnics. The

experts were contacted through emails, letters, and phone calls to explain the research purpose, procedures, and consent to research participation (Mohd Effendi Ewan Mohd Matore & Ahmad Zamri Khairani, 2015a). The CVR findings showed that eight items (numbers 10, 22, 29, 33, 35, 69, 91, and 166) were purified as the value of each item was below 0.332 (critical value). The examples include item 29 (I will still continue my life despite the loss of a loved one), item 35 (I believe that the Lord's blessings will remain, despite the lack of pocket money), and item 166 (I believe that my lazy nature will not last long). According to the experts, the items are suitable for measuring the adversity quotient. The overall 220 items were retained because the focus of the face and content validity is to gain feedback for clarifying any problematic items in terms of the difficulty and misunderstanding of the items.

2.9 Pilot and actual study

A total of 943 students from one polytechnic in the West zone were randomly selected to determine the validity and reliability of the research instrument. The purpose is to identify the items that do not meet the model's expectation as well as having weak psychometric properties. Through this pilot study, the number of items was reduced significantly to 112 items for the actual study. During the actual study, the items were administered to 1,845 polytechnic students across gender, year of study, and type of programme. The findings for both the pilot and actual study using Rasch analysis are depicted in Table 3.

2.10 Construct validation using CFA

The construct validity using CFA was conducted on another sample taken from 1,845 polytechnic students randomly.

2.11 Measures

The AQ items were generated based on 55 challenges and 4 constructs of AQ. A total of 220 items would be answered using a four-point Likert scale with 4 for "strongly agree" (SA), 3 for "agree" (A), 2 for "disagree" (D), and 1 for "strongly disagree" (SD). The items would be accepted for Rasch analysis if several criteria were met such as item fit, unidimensionality, and local independence. This is followed by item polarity, gender differential item functioning (GDIF), person and item reliability, Cronbach alpha, and person and item separation index. Subsequently, another round of Rasch analysis would be performed with Confirmatory Factor Analysis (CFA) to assess the aspect of dimensionality.

For CFA reporting, the measure covers three aspects such as dimensionality, validity, and reliability. The dimensionality looks into the factor loading for each construct, while the validity aspect measures convergent and discriminant validity. The construct validity measures the goodness of fit to see the model's fitness through three main categories: Absolute Fit (RMSEA, GFI, and RMR); Incremental Fit (AGFI, CFI, TLI, NFI); and Parsimonious Fit (Chisq/df) (Zainuddin Awang, 2013). The model fit was assessed based on Root Mean Square Error Approximation (RMSEA), Goodness of Fit Index (GFI), Root Mean Square Residual (RMR), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), Tucker Lewis Index (TLI), Normed Fit Index (NFI), and Chi-square/ degree of freedom ($\chi 2/df$). Finally, the reliability aspect includes Cronbach's alpha (CA), Average Variance Extracted (AVE), and Composite Reliability (CR).

2.12. Statistical analysis

The psychometric properties of the items were explored using classical test theory (CTT) and Rasch analysis with a variation of item response theory (IRT). The statistics involved the pilot phase of Rasch, followed by the actual study using Rasch and the construct validity testing using CFA. Table 3 and Table 4 show the data quality and acceptability for Rasch and CFA.

3. Results and discussions

Table 3 displays the comparison of psychometric properties between the pilot and the actual study. Based on the table, the reliability and validity of the items are good and satisfactory in Rasch analysis. This emphasizes that the items were improved in terms of psychometric properties. In addition, based on the point-measure correlation, all of the items demonstrated a good correlation of above 0.30 that supports evidence of construct validity, indicating that all of the items are working together to define the AQ constructs. With regard to measurement invariance, the DIF analysis showed that 25 items demonstrated significant DIF Contrast statistics, indicating a threat to the measurement invariance property of the items. Out of 25 items, 11 items were favored by the male respondents, while 14 were favored by the female respondents. Upon judgmental considerations, all of these items were dropped from the final version of the instrument. When analyzed again, the 66 items demonstrated compliance with RMM assumptions as well as having good evidence of construct

validity.

Validity evidence of the measurements is presented in three aspects: reliability, construct validity, and DIF analysis. The overall item difficulty reliability coefficient was 0.98, while that of each construct was calculated within 0.96 to 0.99. This shows that it is highly likely that the ordering of the items is consistent if the instrument were administered to other comparable samples of respondents. The overall respondents' ability reliability coefficient was calculated at 0.92, while each construct reported an acceptable reliability coefficient within 0.72 to 0.80. Construct validity assessment evidence was provided based on two criteria comprising the fit statistics and an assessment of gaps between subsequent item measures. The first criterion was covered in the investigation of the RMM assumption section.

Confirmatory Factor Analysis (CFA) – Researchers can choose two methods to run the CFA. The first method is by running it separately for each latent construct, while the second method is by running the CFA simultaneously for all latent constructs. The second method was chosen because it is preferable and can address the issue of model problem identification (Zainuddin Awang, 2013). The sample size is also sufficient according to Hair, Black, Babin, and Anderson (2010) since research needs only 100 samples for five and fewer latent constructs. Each latent construct in this study has more than three items. The measurement model yielded a satisfactory and good fit (see Table 4). The general model of the goodness of fit was assessed using six criteria such as Chi-square/degree of freedom (χ2/df), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), Tucker Lewis Index (TLI), and Root Mean Square Error Approximation (RMSEA) (Md Fauzi Ahmad, 2017). Based on the literature, a model needs at least one index from each category to be considered fit (Hair et al., 2010). The bold indexes as shown in Table 4 are suggested by most literature (Zainuddin Awang, 2015).

Unidimensionality

Unidimensionality is fulfilled when the items have acceptable factor loadings for the latent construct. Any item with a low factor loading may be deleted to ensure unidimensionality. For newly developed items, the factor loading for every item should exceed 0.5 and exceed 0.6 for a reputable item (Zainuddin Awang, 2015). The cutting score for the loading factor of this study would not be less than 0.5 because the items were newly developed. The findings revealed that the factor loadings range from 0.50 to 0.61 as shown in Figure 2.

Validity

The convergent and discriminant validity are the types of validity assessed in this study. The convergent validity was fulfilled using Average Variance Extracted (AVE), which should be 0.5 or higher. The construct validity was accomplished when the fitness indexes passed the required level for each construct as shown in Table 6.

For absolute fit, the findings showed improvement from 0.044 to 0.039 after modification. This value indicates a close fit of the model with a reasonable error of approximation. GFI improved, well-fitted, and acceptable with 0.977, while the RMR finding was satisfactory (less than .05). Findings from incremental fit indicated that the items were well-fitted to the models and accepted with a value greater than 0.90. Parsimonious fit showed that the p-value for chi-square, χ2 in this study was significant or less than 0.05, which was not accepted as a good model fit or lack of fit. However, this criterion is not pertinent to a sample size of more than 200. The Chi-Square statistics will lack power when small samples are used. As the study applied more than 200, these criteria would be neglected. The χ2/df was 3.874 ($\chi2=321.527$, $p<0.05$, $df=83$) and considered as the recommended value for χ2/df that should be within the range from 5.0 (Wheaton, Muthén, Alwin, & Summers, 1977) to 2.0 (Tabachnick & Fidell, 2008). The CMIN/DF (χ2 / df) is the minimum discrepancy allocated by its degrees of freedom and the ratio must be near to one for the correct models. As such, past researchers have suggested 2 to 5 to be indicated as a reasonable fit (Marsh & Hocevar, 1985).

Reliability

The Cronbach's alpha (CA) was 0.798 and considered satisfactory for internal consistency. The CA for each construct was within 0.59 to 0.68. Hair, Black, Babin, and Anderson (2006) mentioned that, occasionally, the cut-off point of 0.5 is acceptable. The internal consistency for each construct of AQ is achieved. The findings (see Table 5 and 6) indicated that the data had insufficient evidence on convergent validity as the AVE value was slightly less than 0.5. However, discriminant validity was not achieved as the diagonal value (in bold) clearly shows that the value is less than the value in its row and column except for the Ownership construct.

For Composite Reliability (CR), the assessment

for reliability should be 0.6 and above and the CR or factor loadings for each construct achieved within 0.60 to 0.65. The scale was proven to be empirically adequate for convergent elements once the average variance extracted (AVE) of each construct reached at least 0.5. Modification indices (MI) showed several pairs for modifications (e1-e2, e9-e10, e10-e11, e10-e12), which were considered high and deemed redundant with above 15 (Zainuddin Awang, 2013). Modifications were only made for the items located within the same construct. The item pair of (e9-e10) was modified due to the largest value of par change with 0.043, which could estimate the parameter change as shown in Figure 1. This modification successfully improved the results for all components of fitness categories. This result will open more discussions on how we can generate more quality items with a high loading factor.

The items exhibited good psychometric properties through a combination of Rasch analysis and confirmatory factor analysis. This finding was also supported by the input from the experts and practitioners. The result consisted of four constructs, each with four single items except for Ownership with three single items. This empirical testing was consistent with the theoretical construct suggested by Stoltz (1997). The findings also responded to the issues of psychometric problems that occurred from the original instruments, which did not detail the aspect of reliability and validity. Empirical data findings demonstrated that the psychometric properties are adequate and appropriate. The new instrument requires approximately 20 minutes to be answered completely. Table 7 shows the list of the final items for measuring AQ.

This study has empirically proven that 15 items, overall, have high validity and reliability. Through this study, this instrument has overcome all of the issues raised by previous researchers such as instrument adaptation and several item psychometric barriers in terms of different contexts on applications Angelopoulos et al., 2002; Anik Budi Utami & Lydia Freyani Hawadi, 2006; Primatika Fatma Rahastyana & Laily Rahmah, 2010). This issue has been addressed through item development in the local context for a better adaptation to the situation as well as the examination of psychometric features such as the use of the item response theory.

The second issue involves the ambiguousness of adversity (Rahmat Aziz, 2008). This issue can be overcome through the new adversity identified in this study in the adversities identification phase. In this phase, the challenges identified are new and not adapted from any challenges in other instruments of AQ. This study has adapted challenges from the Mooney Problem Check List to obtain 55 major challenges for the polytechnic students to be matched with the AQ construct.

Previous studies have also shown that instruments use various languages such as the Indonesian language (Teddy Djuliarki Kurniawan, 2011). In fact, there are also instruments in Chinese and Thai that may cause misunderstanding due to mistranslation. This study has overcome this problem through the development of the items in the Malay language that can be directly used for research purposes. As such, there is no need for a direct or back-translation.

In addition, other issues involve the unfairness of the items (Imroatul Hajidah, 2009). There are not many studies that discuss the issue of item fairness; however, this study used GDIF analysis to overcome this problem. GDIF can ensure that the items are not favorable to any of the groups tested. As such, this study applied the Rasch model and the CFA to further strengthen the aspects of construct validity testing as well as unidimensionality.

The last issue is related to inadequate methodological aspects such as some issues on validity and reliability (Bakare, 2015; Kanjanakaroon, 2012; Pasaribu, 2011; Thi, 2007). This study takes the initiative to improve this situation through the improvement of AQ items by using Miller and Lovler's (2015) item development model, which thoroughly involves three phases: need analysis, development, and validation. Thus, the issues raised have been holistically improved in this study.

4. Research implications

Based on the research focus, psychometric assessment and development issues are critical for accurate instrumentation. In addition, this study has directly contributed to the development and replication of the CORE model from the context of work culture to the context of education. This effort is very meaningful in diversifying the definition of AQ in all CORE model constructs to support the main definition by Stoltz (1997). It also contributes to the use of classical and modern measurement theories in the testing of the items that are deemed more dynamic as they have opened a broader view of the capabilities of the analysis. In addition, the measurement of AQ items in the local context increases the potential to develop a body of knowledge on the relationship of AQ with other variables such as self-adjustment, personality traits,

and motivation achievement. Besides, the AQ knowledge corpus will be more developed and give new paradigms and colors in the self-development diversity of students' resiliency in polytechnics.

5. Research limitations

This research has several limitations. Firstly, the focus group was limited to one polytechnic per zone even though Malaysia has many polytechnics. This will limit the chances to have many views from the polytechnic students with a variety of abilities. Secondly, the instrument developed was only applicable within the polytechnic context; however, the applications for worldwide technical institutions are likely to be the best approach for revising the instrument in the future. Thirdly, the study only focuses on a quantitative approach that provided good and satisfactory item psychometric properties. More explorations using a qualitative method will help researchers understand and gain new insights into adversities faced by the respondents.

Some important considerations can be suggested for future researchers if they want to use this scale in other settings with non-technical respondents. Future studies may examine the applicability of the items at a different level and stage of educational institutions or programmes. Future studies can also expand their scope to explore more possible constructs of AQ from different perspectives, investigate the pattern of AQ relative to the types of demographic profile, add the element of a qualitative approach to discover challenges, establish the items widely across non-technical institutions, and investigate the effectiveness of the instrument in identifying the individuals with problematic AQ. Hopefully, the items can improve the AQ level of technical students in achieving better knowledge workers for facing 4IR challenges.

This study contributes to the empirical evidence proven by statistical analysis through a combination of the classical test theory and modern psychometric theory. Such research will open the door to improve the quality of items for measuring AQ using different approaches of statistical analysis. Both of these analyses will most proactively prove that the newly developed items are valid and reliable. A few studies had examined the quality of item validation using both Rasch and CFA analysis; hence, this study has filled the gap by developing and validating the items through a survey design involving numerous samples. The findings of the study provided information on how the technical students can be guided based on the AQ constructs. The teachers and counsellors may further discuss how these constructs can be improved to increase the quality of AQ as a whole. Teachers should apply these items to the students by providing the AQ profile to ensure that the level of AQ is more presentable and understandable. The students themselves should also take an action to improve their AQ based on their score, while the teachers can improvise the self-development programme with a more creative approach or simulations on how to deal with adversities. The items can be used to identify students who have problems with their AQ as guidance of self and peer assessment.

Correspondingly, the students need to be given chances and exposure to the problems that they may face in the future. The mentoring system is, therefore, suitable to be implemented so as to prepare the students with job challenges besides encouraging them to always be positive in life. Further, polytechnics should invite successful alumni to share their experiences on the best way to overcome the obstacles in life. The technical institutions should put more effort into considering the best way to overcome the students' problems in handling adversities. Although this study is limited in terms of the number of polytechnics, it can provide empirical evidence to substantiate the items as an effective tool. Ultimately, counsellors and teachers are encouraged to use this tool so that they can identify the appropriate interventions for the students.

Funding

This research was funded by Malaysian Ministry of Higher Education (MOHE) under Fundamental Research Grant Scheme (FRGS), grant number FRGS/1/2018/SSI09/UKM/02/1.

Acknowledgments

The authors wish to thank all the lecturers and officers from the polytechnics involved for their assistance with data collection. Thanks to the experts for sincere helping with data analyses, scholarly critiques, and invaluable support to me. I would like to give and honor and highly appreciation to Faculty of Education, Universiti Kebangsaan Malaysia (UKM) and School of Educational Studies, Universiti Sains Malaysia (USM).

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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Tables and Figures

Table 1. **Demographic profile**

Demographic		Frequency	Percentage
Gender	Male	994	53.9%
	Female	851	46.1%
Year of study	Year one	619	33.6%
	Year two	287	15.6%
	Year three	939	50.9%
Department	Civil Engineering	490	26.6%
	Electrical Engineering	294	15.9%
	Mechanical Engineering	383	20.8%
	Petrochemical Engineering	32	1.7%
	Marine Engineering	9	0.5%
	Commerce	442	24.0%
	Food Technology	53	2.9%
	Information Technology and Communication	142	7.7%
Zone	Western	456	24.7%
	Northern	393	21.3%
	Southern	375	20.3%
	Eastern	363	19.7%
	Borneo	258	14.0%

Table 2. **Examples of final items for measuring AQ (original version)**

Construct	Examples of items
Control	I was able to control my fear of failing the exam.
	I try not to worry too much about the exam results.
	I need to change my bedtime to get enough sleep every day.
	I have to set aside more time to study.
Ownership	I was able to explain the reason why I was afraid to fail the exam.
	I am determined to get rid of my laziness.
	I am the only one capable of increasing my self-confidence.
	I realized the causes that caused me not to get enough sleep.
Reach	I still prepare well despite my worries about the exam.
	I have a chance to succeed in the interview if I am more confident.
	I like to give ideas even though I realize that I am not very smart.
	I am more comfortable with being honest even if it hurts other people's feelings.
Endurance	I believe that my lazy attitude will not last long.
	I will not be unemployed for a long time after graduation.
	I do not let my mind wander all the time.
	I am definitely able to work in the field I am interested in after leaving the polytechnic.

Table 3. **Comparison of psychometric properties between the pilot and actual study**

Criteria			Acceptance level	Pilot study	Actual study
Sampling	Population			3,012	18,828
	Stratified proportions			30%	10%
	Sampling and Return rate			943 (93.27%)	1,845 (97.52%)
Item fit	Control	Infit MNSQ	0.77 – 1.30 (Fisher, 2007)	0.95 to 1.29	0.87 to 1.11
		Outfit MNSQ	0.77 – 1.30	0.94 to 1.30	0.95 to 1.12
		Logits		- 0.80 to 0.58	- 0.90 to 0.49
	Ownership	Infit MNSQ	0.77 – 1.30	0.83 to 1.27	0.87 to 1.26
		Outfit MNSQ	0.77 – 1.30	0.85 to 1.30	0.86 to 1.28
		Logits		- 0.57 to 0.63	- 0.43 to 0.67
	Reach	Infit MNSQ	0.77 – 1.30	0.82 to 1.23	0.84 to 1.27
		Outfit MNSQ	0.77 – 1.30	0.81 to 1.26	0.85 to 1.26
		Logits		- 0.48 to 0.37	- 0.37 to 0.50
	Endurance	Infit MNSQ	0.77 – 1.30	0.83 to 1.18	0.83 to 1.21
		Outfit MNSQ	0.77 – 1.30	0.81 to 1.24	0.87 to 1.22
		Logits		- 0.50 to 0.36	- 0.53 to 0.27
Unidimensionality	PCA		> 20% (Reckase, 1979)	21.6 %	21.3 %
	Expected model			21.8 %	21.5 %
	Noise		<10% (Eakman, 2012; Linacre, 2007)	3.2 %	3.2 %
	Variance ratio		Minimum 3:1 (Linacre, 2012)	3.82:1	3.93:1
	Eigen			4.2	2.7
Local independence	Largest standardized residual correlation			0.31 – 0.44	0.20 – 0.29
Item polarity	Control			0.35 to 0.45	0.36 to 0.48
	Ownership			0.31 to 0.51	0.33 to 0.48
	Reach			0.37 to 0.56	0.33 to 0.49
	Endurance			0.38 to 0.57	0.37 to 0.51
GDIF	Control	DIF Contrast	± 0.5 (Lai & Eton, 2002)	- 0.22 to 0.19	- 0.15 to 0.15
		t	± 2.0 (Bond & Fox, 2015)	- 1.95 to 1.53	- 1.79 to 1.85
	Ownership	DIF Contrast	± 0.5	- 0.21 to 0.16	- 0.13 to 0.09
		t	± 2.0	- 1.89 to 1.25	- 1.64 to 1.07
	Reach	DIF Contrast	± 0.5	- 0.23 to 0.19	- 0.15 to 0.15
		t	± 2.0	- 1.99 to 1.57	- 1.83 to 1.78
	Endurance	DIF Contrast	± 0.5	- 0.22 to 0.18	- 0.12 to 0.14
		t	± 2.0	- 1.92 to 1.49	- 1.51 to 1.61
Person reliability	Overall		> 0.7 (Bond & Fox, 2015)	0.95	0.92
	Control		> 0.7	0.80	0.73
	Ownership		> 0.7	0.85	0.79
	Reach		> 0.7	0.87	0.80
	Endurance		> 0.7	0.88	0.79
Item reliability	Overall		> 0.7 (Bond & Fox, 2015)	0.95	0.98
	Control		> 0.7	0.98	0.99
	Ownership		> 0.7	0.96	0.98

	Reach	> 0.7	0.93	0.98
	Endurance	> 0.7	0.92	0.96
Cronbach's Alpha	Overall	> 0.7 (Hair, Celsi, Oritinau, & Bush, 2017)	0.96	0.94
	Control	> 0.7	0.84	0.78
	Ownership	> 0.7	0.88	0.82
	Reach	> 0.7	0.90	0.83
	Endurance	> 0.7	0.91	0.84
Person separation	Overall	> 2.0 (Bond & Fox, 2015)	4.50	3.50
	Control	> 2.0	1.98	1.64
	Ownership	> 2.0	2.42	1.92
	Reach	> 2.0	2.59	1.98
	Endurance	> 2.0	2.72	1.91
Item separation	Overall	> 2.0	4.57	7.60
	Control	> 2.0(Bond & Fox, 2015)	6.33	9.82
	Ownership	> 2.0	4.93	7.99
	Reach	> 2.0	3.69	6.59
	Endurance	> 2.0	3.31	5.05

Table 4. **Summary of the fitness index of the measurement model**

Fitness category	Name of index	Indices value (pre-modification)	Indices value (post-modification)	Comments for the level of acceptance
Absolute Fit	**RMSEA**	0.044	0.039	RMSEA ≤ 0.05 Acceptable (Browne & Cudeck, 1993)
	GFI	0.972	0.977	GFI ≥ 0.95 Acceptable (Miles & Shevlin, 1998)
	RMR	0.014	0.013	RMR ≤ 0.05 Acceptable (Diamantopoulos & Siguaw, 2000; Hu & Bentler, 1999)
Incremental Fit	AGFI	0.961	0.966	AGFI ≥ 0.9 Acceptable (Miles & Shevlin, 1998)
	CFI	0.936	0.950	CFI ≥ 0.9 Acceptable (Hu & Bentler, 1999)
	TLI	0.920	0.936	TLI ≥ 0.9 Acceptable (Bentler & Bonett, 1980; Hu & Bentler, 1999)
	NFI	0.920	0.933	NFI ≥ 0.9 Acceptable (Bentler & Bonett, 1980; Hu & Bentler, 1999)
Parsimonious Fit	**χ2/df**	4.594	3.874	χ2/df ≤ 5.0 is acceptable (Marsh & Hocevar, 1985)

Table 5. **Index summary for discriminant validity**

Construct	C	O	R	E
C	**0.563**			
O	0.433	**0.573**		
R	0.619	0.449	**0.556**	
E	0.623	0.538	0.691	**0.567**

Table 6. **CFA results of the measurement model**

Construct	Numbering (Rasch pilot)	New numbering (CFA pilot)	Factor Loading (≥ 0.5)	Cronbach's Alpha (≥ 0.5)	CR (≥ 0.6)	AVE (≥ 0.5)
Control	AQ15	AQ7	0.54	0.65	0.65	0.32
	AQ18	AQ8	0.54			
	AQ21	AQ9	0.60			
	AQ23	AQ11	0.58			
Ownership	AQ28	AQ13	0.58	0.59	0.60	0.33
	AQ34	AQ17	0.54			
	AQ35	AQ18	0.60			
Reach	AQ75	AQ43	0.55	0.64	0.64	0.31
	AQ76	AQ44	0.56			
	AQ79	AQ47	0.55			
	AQ83	AQ49	0.56			
Endurance	AQ90	AQ53	0.57	0.68	0.65	0.32
	AQ91	AQ54	0.50			
	AQ94	AQ56	0.58			
	AQ98	AQ60	0.61			

Table 7. **List of final items for measuring AQ**

Construct	Item	Item
Control	AQ7	The examination anxiety has encouraged me to give my best.
	AQ8	I gradually try to learn computer and information technology skills.
	AQ9	I try not to think too much about the things that can disrupt my life.
	AQ11	I plan my future carefully.
Ownership	AQ13	I am able to think about the ways to repay the money that I have borrowed.
	AQ17	I am determined not to hurt other people's feelings.
	AQ18	I realize that other people sometimes doubt my ability.
Reach	AQ43	I am still confident of getting an opportunity to get a job even though my selection of courses does not guarantee me a job.
	AQ44	I try to highlight all of my potentials and abilities.
	AQ47	I will increase the amount of study time according to my own ability.
	AQ49	I need to immediately stop blaming myself when any problem occurs.
Endurance	AQ53	Proper time planning helps me to obtain adequate time to study.
	AQ54	I will try as much as I possibly could to search for a suitable job.
	AQ56	I am sure that I will not be among those in the weaker cohorts in the next examination.
	AQ60	I can reduce my carelessness if I am often reminded by those who are closest to me.

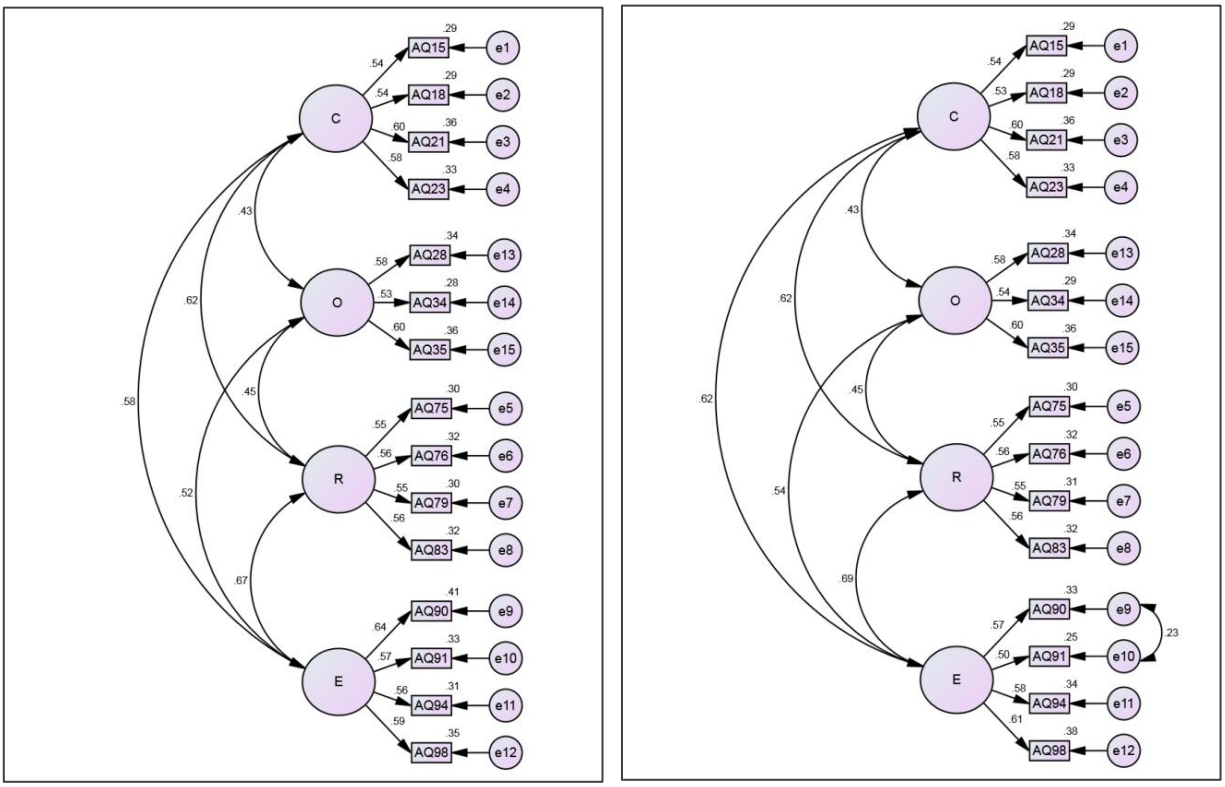

Figure 1. Comparison of the measurement model (pre and post) modifications