'ULŪM ISLĀMIYYAH THE MALAYSIAN JOURNAL OF ISLAMIC SCIENCES
VOL. 31 (AUGUST) 2020 ISSN: 1675-5936 I eISSN: 2289-4799

Exploring Factor Structures Of A Thinking Questionnaire

Hazlina Abdullah
Faculty of Major Language Studies, Universiti Sains Islam Malaysia,
Bandar Baru Nilai, Negeri Sembilan, Malaysia
hazlina@usim.edu.my

Haliza Harun
Faculty of Major Language Studies, Universiti Sains Islam Malaysia,
Bandar Baru Nilai, Negeri Sembilan, Malaysia
haliza@usim.edu.my

Maziahtusima Ishak
Faculty of Major Language Studies, Universiti Sains Islam Malaysia,
Bandar Baru Nilai, Negeri Sembilan, Malaysia
mshima@usim.edu.my

Mikail Ibrahim
Faculty of Major Language Studies, Universiti Sains Islam Malaysia,
Bandar Baru Nilai, Negeri Sembilan, Malaysia
mikail@usim.edu.my

Sakinah Ahmad
Faculty of Major Language Studies, Universiti Sains Islam Malaysia,
Bandar Baru Nilai, Negeri Sembilan, Malaysia
skahmad@usim.edu.my

Abstract

The purpose of this study was to investigate the construct validity of a thinking questionnaire through Factor Analysis over a Malaysian university students' sample. The questionnaire is a 5 point Likert scale survey ranging from Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree, intended to measure students' self-reflection on their thinking upon their Invention Project. A total of 350 undergraduate students from various faculties participated in this study. Principal Component Analysis was used because the primary purpose was to identify and compute composite thinking scores for the factors underlying the Thinking questionnaire. The five factor solution, which explained 52.4% of the variance was chosen because of the ‘levelling off’ of eigenvalues on the scree plot after five factors, and was also confirmed by the Monte Carlo Parallel Analysis which indicated smaller values of the 5 factors compared to the eigenvalues displayed in the SPSS.

Key words: *factor analysis, factor structure, Principal Component Analysis (PCA), thinking questionnaire*

1. Introduction

Thinking is an essential activity in our daily life that is given much discussion but without much action. Complaints and criticisms are often heard, especially from teachers, lecturers and employers, that our students simply do not think (Hazlina Abdullah, Mohd Azmir Mohd Nizah and Hazleena Baharun, 2012). The lack of thinking in one way or another is overtaken by rote learning—where students are so used to repeating, memorising, imitating and restating what they have learned, instead of making an effort to generate new, original and more imaginative thoughts.

Choy and Cheah (2009) mention several issues (e.g. defining critical thinking, teaching critical thinking, and whether it should be taught or learned through social interaction) which have caused a great concern to educators who are considering to improve the thinking skills of their students. However, there are many ways to make thinking visible. According to Perkins (1997), one recommended technique is for teachers to employ the language of thinking for instance reasoning, hypothesising, imagining, giving evidence, providing possibility and offering personal perspective. Another way is to ensure many opportunities for thinking to take place during subject matter learning.

In the Malaysian context, the need to acquire thinking skills is very much in line with the country’s aspirations as manifested in the National Education Philosophy:

> *"Education in Malaysia is an on-going effort towards further developing the potential of individuals in a* ***holistic and integrated*** *manner, so as to produce individuals who are* ***intellectually, spiritually, emotionally and physically balanced and harmonic****, based on a firm belief in and devotion to God. Such an effort is designed to produce Malaysian citizens who are knowledgeable and competent, who possess high moral standards and who are responsible and capable of achieving high level of personal well-being as well as being able to contribute to the harmony and betterment of the family, the society and the nation at large”* Ministry of Education (1993).

Hence, it is clear that developing more holistic, critical and creative learners is in actual fact one of the country’s major educational affairs. Therefore, it is the accountability of educators to directly or indirectly encourage thinking skills.

In facing the era of Industrial Revolution 4.0, the skill to think critically and creatively is crucial for students to live, work, and function effectively in the current and changing society. Students are required to make choices, assess and decide on many aspects in the activities of their daily lives, which involve finding information and grabbing opportunities. Moreover, as grown-ups living in an intricate, yet democratic world, they need to efficiently decide on, deal with and utilise information. All these demand critical and creative thinking skills.

Even so, national and state evaluations have also shown that a high percentage of students in schools are not able to effectively use critical and creative thinking skills (Yee, Widad Othman, Jailani Md Yunos, Tee, Razali Hassan & Mimi Mohaffyza Mohamad, 2011). In addition, business, industry and employers keep on testifying that many fresh graduate employees are incompetent and merely able to think critically and creatively in work environment. From a report on My3S (*Malaysian Soft Skills Scale*) by the Ministry of Higher Education, the score for Critical Thinking & Problem-solving (CTPS) element is the lowest compared to the scores of other elements. This is regrettably true for many public universities in Malaysia including Universiti Sains Islam Malaysia (USIM). The Ministry has then called upon some effective measures in handling this issue, for example incorporating soft skills (which include critical thinking and problem solving skills) into the undergraduate curriculum so that the graduates' employability becomes more enhanced (Hairuzila Idrus, Hazadiah Mohd Dahan & Normah Abdullah, 2010) and also the use of Problem-based Learning in the curriculum (Mohd Nazir Md Zabit, 2010), In response to this, an invention project, a component in the English Language Support Programme 3 (ELSP 3), was designed to promote thinking skills. The inventions were showcased at the USIM Young Inventors Fair.

English Language Support Programme (ELSP)

The English Language Support Programme (ELSP) is divided into three segments—ELSP 1, ELSP 2 and ELSP 3. It is a compulsory programme for all first year students of every faculty at USIM main campus. ELSP 1 takes place in the first semester during the orientation week for new first year students. It is an 18-hour programme which focuses on communicative English. Activities like drama, role play, literary appreciation, grammar and study skills are included. Other components involve motivational talks, dictionary skills and classroom-based lessons that aim to uplift the interest of new undergraduates in using the English language. The main objectives of ELSPs are to provide exposure, and generate interest in English which is hoped to create awareness and interest toward the language. By inculcating this positive attitude, it is expected that students can master the English language (Siaw-Fong Chung, 2017; Siti Martini Mustapha & Ros Aizan Yahaya, 2013).

In the second segment, the ELSP 2, students are directed toward the practice of particular elements of the MUET (Malaysian University English Test) examination. Various strategies and techniques related to MUET are planned for the students to prepare them for the examination. ELSP 2 incorporates study skills activities**,** presentations, poster presentation, forum, public speaking, interview skills and debate. ELSP 2 runs for 30 hours and is very much geared towards MUET in order to provide students the primary and much needed exposure to the national public university entry exam.

ELSP 3 is the final series of the ELSP programme which consists of 28 hours of face-to-face meetings, offered over 7 weeks. This programme serves as an avenue for students to gain knowledge and employ listening, speaking, reading and writing skills of the English language in a more open, relaxed and informal context. Many consolidation and enrichment activities are carried out so as to encourage students to use English extensively. The climax is a group masterpiece where each group is required to complete an assigned final project in the form of presentation or production of related issues.

In ELSP 3, the final project was an invention project**,** exhibited at the USIM Young Inventors Fair. It is through this project that thinking skills were encouraged among students.

The ELSP 3 Invention Project: USIM Young Inventors Fair

The final segment, ELSP3, took place over a period of 7 weeks, filled with consolidation and enrichment activities. One of them was the invention project, in which as a class, the students were required to create or design an invention (in various categories such as home improvement, house wares, automotive, apparel, industrial, medical, garment care, cleaning, hardware, lawn and garden etc.). The inventions were showcased at the allocated venue during the USIM YOUNG INVENTORS FAIR.

2. Factor Analysis Method

Factor analysis is a statistical method extensively used in psychology and the social sciences (Kline, 2014). According to Royce (1963) in Kline (2014), a factor is "a construct operationally defined by its factor loadings" (p. 5). In other words, a factor is a construct which explains the relationships or correlations between variables, while factor loadings are the "correlations between variables and factors" (Kline, 2014, p. 13). This indicates that the meaning of factors is drawn from their loadings. Factor analysis methods can assist researchers to describe their variable more accurately and determine what variables they should study and link each other to develop the study to a greater level. Factor analysis can also help researchers to increase their understanding of the complicated and weak associations amongst large numbers of variables (Comrey & Lee, 2013).

Given the importance and also complexities of thinking as mentioned in the earlier section of the article, many studies are found to employ factor analysis methods to assess and validate thinking dimensions. A study by Tanner, Voon, Hasking & Martin (2013) look at the factor structure of rumination as measured by the Ruminative Thought Style Questionnaire (RTSQ). Their analysis confirms four rumination subcomponents, labelled "Problem-Focused Thoughts", "Counterfactual Thinking", "Repetitive Thoughts", and "Anticipatory Thoughts". Each of these subscales have different contributions to psychological distress and coping styles in separate multiple regressions which suggests that there is a multidimensional structure for rumination. Another interesting study by Walters, Hagman & Cohn (2011) is conducted to determine how well the latent trait of criminal thinking is measured in a group of 2,872 male medium security prison inmates. The study looks at the Psychological Inventory of Criminal Thinking Styles (PICTS) and uses factor analysis to achieve a hierarchical model of criminal thinking.

In their study, Said-Metwaly, Fernández-Castilla, Kyndt & Van den Noortgate (2018) investigate the factor structure of the Figural Torrance Tests of Creative Thinking (Figural TTCT). They test four different factor models presented in the literature to determine which model matches the data best. The results confirm a 2-factor structure model whereby fluency and originality subscales loaded on the innovative factor; elaboration, abstractness of titles, and resistance to premature closure subscales loaded on the adaptive factor. In the area of teacher education, Duchovičová, & Tomšik (2018) present the results of a factor analysis of a questionary Strategies of Critical and Creative Thinking within the Teaching questionnaire (SCCTT). The instrument encompasses 40 items that involve 6 strategies for critical thinking development in the teaching process. These past studies have shown that factor analysis methods are widely used in the area of thinking research, covering various domains.

3. Objective and Research Question

In relation to the Invention Project in ELSP 3 (USIM Young Inventors Fair), the researchers would like to evaluate the perceptions of USIM students on the effectiveness of using the project to promote thinking skills. In doing so, a set of questionnaire which is adapted from Tan (2001) who conducted a study on the effectiveness of a thinking programme among lower secondary students in a Chinese High School, is used as the research instrument. The survey questions are self-reflective statements based on Sternberg, Perkins and Costa theories of thinking behaviours. They deal with many different aspects of thinking, including critical and creative thinking, reflective and metacognitive thinking, self regulation, decision making and problem solving.

In order to elicit more systematic findings, there is a need to explore the factor structures of the questionnaire, alongside simplifying the data structure by revealing a smaller number or underlying factors, and also helping to eliminate or identify items for improvement. This will also increase the construct validity of the questionnaire.

The present study therefore, aims to explore and summarise the underlying correlational structure for the data set obtained. It is guided by the following research question:

What is the underlying factor structure of the Thinking questionnaire?

4. Methodology

Participants

The study involved data-gathering in relation to students' perceptions of their thinking skills upon the completion of the Invention Project assigned to them. A total of 350 first year undergraduate students from different faculties of USIM (Faculty of Major Language Studies, Faculty of Quranic and Sunnah Studies, Faculty of Syariah and Law, Faculty of Economics and Muamalat, Faculty of Leadership and Management and also Faculty of Science and Technology) were the respondents of this study. The students were of mixed gender.

Instrument and Procedure

A quantitative approach was used, through an evaluation survey, which was administered to the 350 students of 1st year Bachelor degree (Refer Appendix 1). The questionnaire was administered during the last session in class, before the USIM Young Inventors Fair took place. The students were given ample time to reflect on the preparation they did for the Fair, and their thinking experiences while completing the project. The questionnaire was adapted from Tan (2001). It consists of 18 statements, using a five-point Likert scale ranging from 'Strongly Disagree' through 'Neither Agree or Disagree' to 'Strongly Agree'. They are self-reflection questions, where the first 10 statements (Q1-Q10) are to check if the students have acquired analytical-critical and creative thinking habits. For example, the ability to focus on problematic issues and thinking of different strategies to analyse problems. Then, there are 6 statements (Q11-Q14 and Q17-Q18)) regarding meta-cognitive thinking and behaviours, such as being aware of their strengths and weaknesses, and another 2 statements (Q15-Q16) on practical thinking like whether the students apply thinking skills after they have completed the project.

5. Results and Discussion

Data Screening

The data were screened for univariate outliers. Twenty out-of-range values, due to administrative errors, were identified and recoded as missing data. The minimum amount of data for factor analysis was satisfied, with a final sample size of 350, with over 19 cases per variable.

Factor Analysis

Construct validity of the questionnaire is searched through a principal component factor analysis. Initially, the factorability of the 18 Thinking questionnaire items was examined. These item level responses were scrutinised for underlying patterns via factor analytic procedures (Note that all procedures reported here utilise SPSS). Several well-recognised criteria for the factorability of correlation were used. Firstly, most of the items correlated at least .3 with at least one other item, suggesting reasonable factorability. Secondly, the Kaiser-Meyer-Olkin measure of sampling adequacy was .85, above the recommended value of .6 (Kaiser, 1960), and Bartlett's test of sphericity was significant (χ^2 (153) = 1090.46, $p < .05$). The diagonals of the anti-image correlation matrix were over .5, supporting the inclusion of each item in the factor analysis. Finally, the communalities were all above .3 (See Table 1), further confirming that each item shared some common variance with other items. Given these overall indicators, factor analysis was conducted with all 18 items.

Principal component analysis was used because the primary purpose was to identify and compute composite thinking scores for the factors underlying the Thinking questionnaire (Tabachnick & Fidel, 1996). The initial eigenvalues showed that the first factor (Analytical Thinking Habits) explained 27.2% of the variance, the second factor (Critical Thinking Habits) 6.8% of the variance, the third factor (metacognitive Thinking) 6.7%, the fourth factor (Metacognitive Behaviour) 6.1%, and the fifth factor (Practical Thinking) 5.6% of the variance. The five factor solution, which explained 52.4% of the variance was chosen because of the 'levelling off' of eigenvalues on the scree plot after five factors, and was also confirmed by the Monte Carlo Parallel

Analysis which indicated smaller values of the 5 factors compared to the eigenvalues displayed in the SPSS.

Based on Stevens (1996), in order to accept an item under a dimension, factor loading value of .40 and above were taken as a cut off value. All items were all positive and had primary loadings over .4 and only one item had a cross-loading above .3 (*Helped in academic learning*), however this item had a strong primary loading of .61. The factor loading matrix for this final solution is presented in Table 1.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.899	27.214	27.214	4.899	27.214	27.214	2.172	12.066	12.066
2	1.230	6.835	34.049	1.230	6.835	34.049	2.151	11.949	24.016
3	1.204	6.690	40.739	1.204	6.690	40.739	2.042	11.346	35.362
4	1.099	6.105	46.843	1.099	6.105	46.843	1.629	9.048	44.409
5	1.002	5.565	52.409	1.002	5.565	52.409	1.440	7.999	52.409
6	.968	5.380	57.789						
7	.920	5.112	62.901						
8	.862	4.789	67.690						
9	.778	4.324	72.015						

10	.739	4.107	76.122
11	.698	3.879	80.001
12	.633	3.519	83.520
13	.599	3.330	86.850
14	.550	3.057	89.907
15	.509	2.825	92.732
16	.491	2.729	95.461
17	.449	2.497	97.958
18	.368	2.042	100.000

Extraction Method: Principal Component Analysis.

Table 1:
*Factor loadings and communalities based on a principal components analysis with varimax rotation for 18 items from the Thinking questionnaire (*N *= 357)*

	Analytical Thinking habits	**Critical Thinking habits**	**Meta-cognitive Thinking**	**Meta-cognitive Behaviour**	**Practical Thinking**	**Communality**
More aware and ask questions to understand	.743					.61
Learn own stregth an weakness in competition	.642					.55
Hepled in academic learning	.605					.56
Learn to probe by specific question	.530					.44
Enjoy problem solving/decision making		.672				.56
Learn to listen		.645				.50
Able to evaluate new ideas		.579				.46
Improved ability detecting biasness		.509				.40
Do not give up easily		.478				.48
Improved ability using different strategies			.772			.64
Focus by			.592			.44

asking right questions				
Applying thinking skills in real life situation	.517			.41
Improved thinking skills	.508			.40
Less afraid making mistakes		.821		.73
Less afraid to express thought		.785		.70
Become less impulsive			.816	.68
Liked challenges			.468	.46
More ready to describe own thinking strategies			.412	.40

Note. Factor loadings < .4 are suppressed

The characteristics proposed by Sternberg, Perkins and Costa theories of thinking behaviours suited the five extracted factors. Internal consistency for each of the scales was examined using Cronbach's alpha. The alphas were moderate: .66 for *Factor 1: Analytical Thinking Habits* (4 items), .62 for *Factor 2: Critical Thinking Habits* (5 items), .60 for *Factor 3: Metacognitice Thinking* (4 items) , .66 for *Factor 4: Metacognitive Behaviour* (2 items) and .45 for *Factor 5: Practical Thinking* (3 items). No substantial increase in alpha for any of the scales could have been achieved by eliminating any items.

The five factors

Four items loaded onto Factor 1. This factor was labelled "*Analytical Thinking habits*". Five items load onto a second factor which was labelled "*Critical Thinking Habits*". Next, the four items that load onto factor 3 was labelled "*Meta-cognitive Thinking*". Items for Factor 4 was labelled "*Meta-cognitive Behaviour*", and lastly three items load onto Factor 5 labelled as "Practical Thinking".

Composite scores were created for each of the five factors, based on the mean of the items which had their primary loadings on each factor. Higher scores indicated greater use of the Thinking skill components. *Meta-cognitive behaviour* was the factor that students reported gained the most, followed by *Practical thinking*, whilst *Meta-cognitive thinking*, *Critical thinking habits* and *Analytical thinking habits* were considerably similarly gained. Descriptive statistics are presented in Table 2. An examination of the histograms suggested that the distributions looked approximately normal (see Appendix 2).

Table 2:

*Descriptive statistics for the five Thinking questionnaire factors (*N *= 537)*

	No. of Items	Mean	Alpha
Analytical Thinking habits	4	1.81	.66
Critical Thinking habits	5	1.81	.62
Meta-cognitive Thinking	4	1.82	.60
Meta-cognitive Behaviour	2	2.09	.66
Practical Thinking	3	1.92	.45

6. Conclusion

Overall, these analyses indicated that five distinct factors were underlying students' responses to the Thinking questionnaire items, and that these factors were moderately internally consistent. All eighteen items were retained. An approximately normal distribution was evident for the composite score data in the current study, thus the data were well suited for parametric statistical analyses. Such a rating scale can help obtain feedback from the participants on the strength and direction of their feelings about the Invention project towards their thinking. Another plus point of this self-reflective questionnaire using the rating scale is that it was able to elicit responses to specific research questions in the form of scaled, quantifiable data which can then be subjected to powerful statistical analyses (Bachman et al, 1996).

Results of the current study also have implications regarding theoretical concetualisations of thinking in research and practice as well as intervention. Although thinking may be difficult to be conceptualised, there are many ways to make thinking visible (Perkins, 1997; Hazlina Abdullah et.al., 2012). Given that there are a number of measures purporting to measure thinking—specifically the Thinking Questionnaire adapted in this study—would be beneficial. Nevertheless, further investigations into the construct validity in different contexts e.g. at the kindergarten, primary and secondary levels are therefore warranted.

Finally, while most identified factors were found to contribute to five factors—Analytical Thinking Habits, Critical Thinking Habits, Meta-cognitive Thinking, Meta-cognitive Behaviour and Practical Thinking, the cross-sectional nature of the analysis precludes any conclusions regarding the differential contribution of these factors to the different thinking programmes being evaluated upon. Yet, this study established a five-factor structure of thinking components which provides support for the notion of thinking as a multidimensional and multifaceted construct. Future research identifying sources of convergent and discriminant validity would provide further refinement of these factors in addition to examining whether they are differentially associated with other educational programmes.

Acknowledgement

Special thanks to Assoc. Prof. Dr. Bhasah Abu Bakar for his constructive comments and feedback.

References

Bachman, L. F., Davidson, F., and Milanovic, M. (1996). The use of test method characteristics in the content analysis and design of EFL proficiency tests. *Language Testing* 13 (2), 125-150.

Choy, S., & Cheah, P. (2009). Teacher perceptions of critical thinking among students and its influence on higher education. *International Journal of Teaching and Learning in Higher Education*, *20*(2), 198-206.

Comrey, A. L., & Lee, H. B. (2013). *A first course in factor analysis*. Psychology Press.

Costa, A. L. (Ed.). (1985). *Developing minds: A resource book for teaching thinking*, 1st edition. Alexandria, VA: Association for Supervision and Curriculum Development.

Duchovičová, J., & Tomšik, R. (2018). Managerial competencies of a teacher in the context of learners' critical thinking development: exploratory factor analysis of a research tool and the results of the research. *TEM Journal*, *7*(2), 335.

Hairuzila Idrus, Hazadiah Mohd Dahan & Normah Abdullah (2010). Integrating critical thinking and problem solving skills in the teaching of technical courses: The narrative of a Malaysian private university. 2nd International Congress on Engineering Education, December 8-9, 2010, Kuala Lumpur, Malaysia.

Hazlina Abdullah, Mohd Azmir Mohd Nizah & Hazleena Baharun (2012). Promoting thinking skills: An evaluation of the effectiveness of an invention project. *Elixir Social Studies* 44, 7178-7187.

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. Educational and Psychological Measurement, 20, 141-151.

Kline, P. (2014). *An easy guide to factor analysis*. Routledge.

Laporan Penilaian My3S (*Malaysian Soft Skills Scale*). Kementerian Pengajian Tinggi Malaysia. 18 Disember 2010.

Ministry of Education (1993), *Education in Malaysia,* Educational Planning and Research Division, Kuala Lumpur.

Mohd Nazir Md Zabit (2010). Problem-Based learning on students' critical thinking skills in teaching Business Education in Malaysia: A literature review. *American Journal of Business Education*, Volume 3, Number 6, pp. 19-32.

Perkins (1997) in http://www.newhorizons.org/strategies/thinking.htm.

Said-Metwaly, S., Fernández-Castilla, B., Kyndt, E., & Van den Noortgate, W. (2018). The factor structure of the Figural Torrance Tests of Creative Thinking: A meta-confirmatory factor analysis. *Creativity Research Journal*, *30*(4), 352-360.

Siaw-Fong Chung (2017). A communicative approach to teaching grammar: theory and practice. The English Teacher, pp. 33-50.

Siti Martini Mustapha & Ros Aizan Yahaya (2013). Communicative Language Teaching (CLT) in Malaysian Context: Its' Implementation in Selected Community Colleges. Procedia Social and Behavioural Sciences, Vol. 90, pp. 788-794.

Stevens, J. (1996). Applied multivariate statistics for the social sciences. New Jersey: Lawrence Erlbaum Associates Publishers.

Tabachnick, B. G., & Fidell, L. S. (1996). Using multivariate statistics (3rd ed.). New York: Harper Collin.

Tan, G.Y.H (2001). *Analysis and evaluation of the thinking programme in developing critical and creative thinking among lower secondary students in the Chinese High School.* A paper presented at the *AARE Conference 2001* (Association for Active Educational Researchers). http://www.aare.edu.au/01pap/tan01755.htm

Tanner, A., Voon, D., Hasking, P., & Martin, G. (2013). Underlying structure of ruminative thinking: Factor analysis of the Ruminative Thought Style Questionnaire. Cognitive Therapy and Research, 37, 633-646.

Walters, G. D., Hagman, B. T., & Cohn, A. M. (2011). Toward a hierarchical model of criminal thinking: Evidence from item response theory and confirmatory factor analysis. *Psychological Assessment*, *23*(4), 925.

Yee, Widad Othman, Jailani Md Yunos, Tee, Razali Hassan & Mimi Mohaffyza Mohamad (2011). The level of Marzano higher order thinking skills among technical education students. *International Journal of Social Science and Humanity*, 1 (2), 121-125.

Appendices

Appendix 1: QUESTIONNAIRE

A Self-reflection on Your Thinking &

The Invention Project of ELSP 3:

USIM Young Inventors Fair

Name : ________________________ (optional)

Group : _________

Please indicate by ticking the box, the extent to which you agree or disagree with each statement regarding the ELSP 3 Competition: USIM Young Inventors Fair.

SA = *Strongly Agree* **A** = *Agree* **NA** = Neither Agree or Disagree **DA** = *Disagree* **SD** = *Strongly Disagree*

		SD	**DA**	**NA**	**A**	**SA**
1.	I learned how to focus on issues/problems by asking the right questions to my friends and teacher.					
2.	I improved my ability to use different strategies to problems.					
3	I do not give up easily and learn to persevere when answers to issues/problems are not evident.					
4.	I become less impulsive by taking my time to reflect on answers/arguments before giving them.					
5.	I learn to listen and respect alternate viewpoints.					
6.	I am able to evaluate the merits and demerits of new ideas.					
7.	I improve my ability to use different thinking					

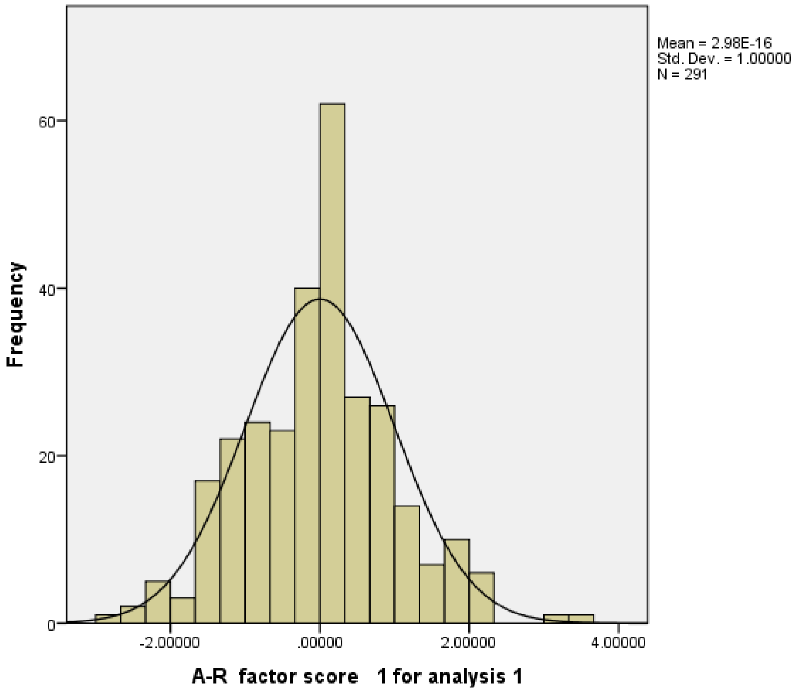
	skills to generate new ideas/solutions.					
8.	I like the challenge of thinking of new ideas.					
9.	I enjoy problem-solving/decision-making.					
10.	I improve my ability to detect errors/bias.					
11.	I am more ready to describe/draw/write down my own thinking strategies.					
12.	In the competition, I learn about my own strength and weaknesses by reflecting on my actions.					
13.	I am more aware of things around me and ask more questions so as to understand something better.					
14.	I learn to probe by asking more specific questions.					
15.	The thinking skills that I learn have helped me in my academic learning.					
16.	I apply the thinking skills learned in class to real-life situations.					
17.	I am less afraid to express my thoughts/ideas.					
18.	I am less afraid to make mistakes.					

(Adapted from Tan, 2001)

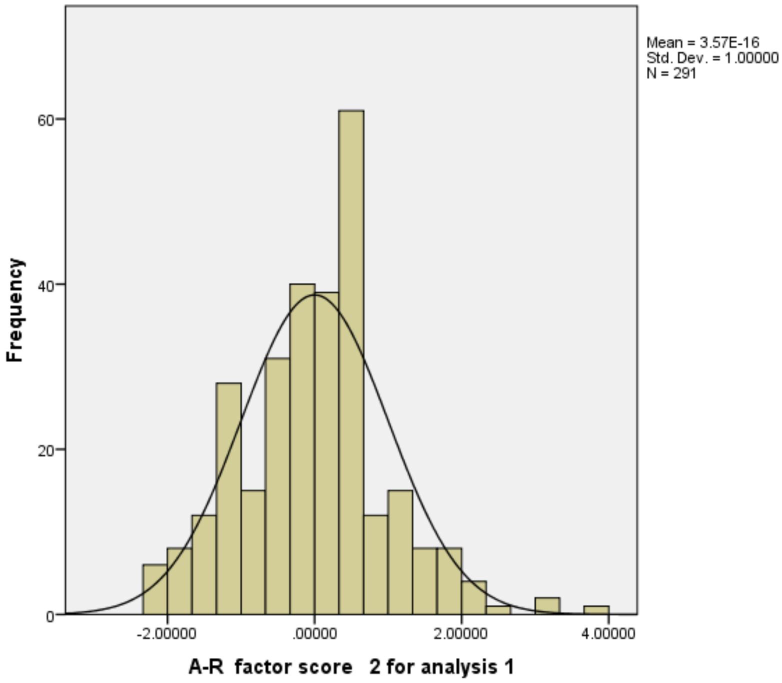
Appendix 2:

Histograms of the distribution of students' responses to the composite Thinking questionnaire.

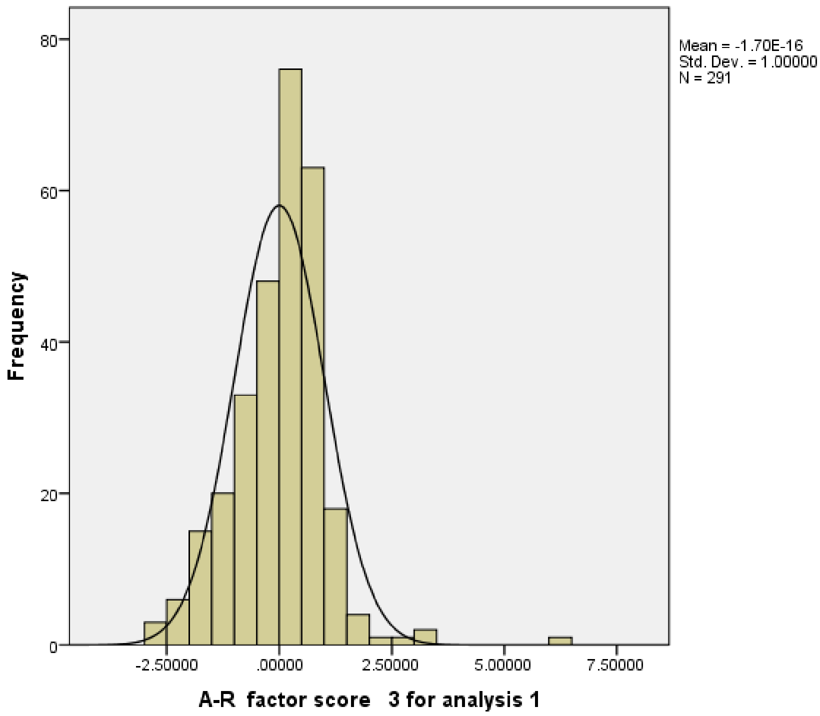
Factor 1: Analytical Thinking habits



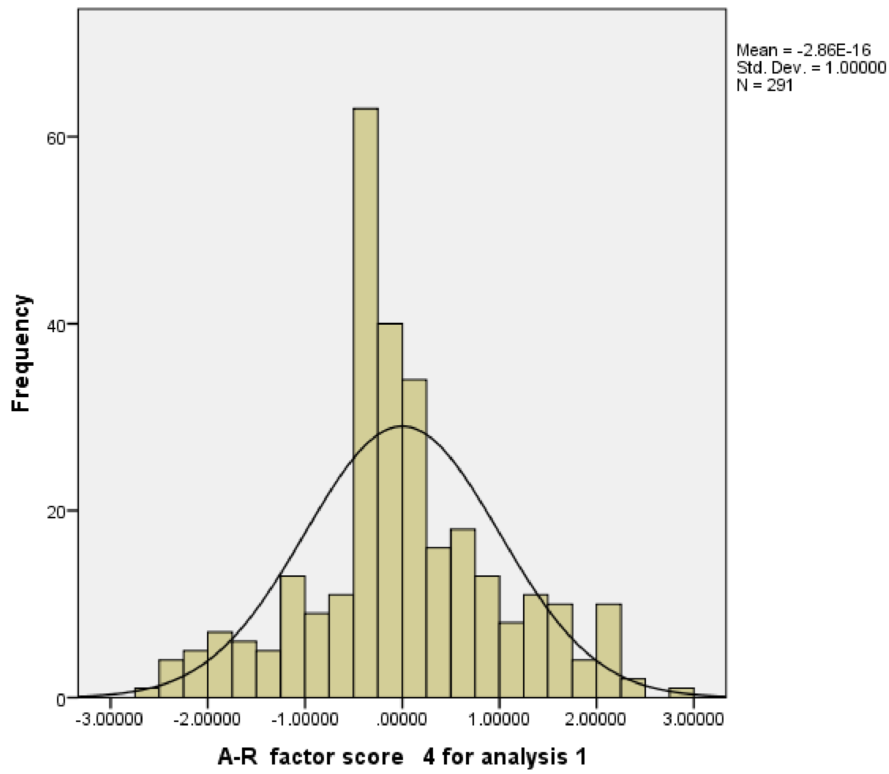
Factor 2: Critical Thinking habits



Factor 3: Meta-cognitive Thinking



Factor 4: Meta-cognitive Behaviour



Factor 5: Practical Thinking