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The Effects of Inventive Thinking Programme on Bahasa Melayu Students' Inventive Thinking Ability and Dispositions

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Abstract

Inventive Thinking has been identified as one of the core skills needed by the workforce in the 21st Century. As a result, there have been numerous efforts to develop various teaching and learning programmes that could empower students' ability in thinking inventively. This study aimed to (1) record and explore, that is by using a series of inferential statistical analyses by means of the Solomon Four-Group Design, of any shift in the participants' Inventive Thinking abilities and dispositions after the introduction of an intervention programme; and (2) give insights thus, to evaluate the 'effectiveness' of the developed intervention programme which was incorporated in the Bahasa Melayu classes. A total of 125 students enrolled in the Bahasa Melayu Brunei-Cambridge GCE A Level in Negara Brunei Darussalam participated in the study. In this study, their Inventive Thinking abilities and dispositions were measured by using The Inventive Problem Solving Quiz and The Inventive Thinking Survey Form pre and post interventions. As a result, the intervention programme contributed to the poorer performance at the quiz by the participants in the experiment group (M = 42.2, SD = 8.9) as compared to those in the control group (M=45.8, SD = 5.9), F (1,121) = 5.5, p = .02). Interestingly, it was the experiment group who outperformed the other group in The Inventive Thinking Survey Form (M = 2.8, SD = .29, as opposed to M = 2.7, SD = .4; F (48, 1) = 5.9, p = .02).

Keywords: Inventive Problem Solving, Inventive Thinking, Teaching Thinking, ASIT

1. Introduction

Alongside of Effective Communications, Digital-Age Literacy and High Productivity, Inventive Thinking has been identified as an important skill for academic achievements (North Central Regional Educational Laboratory and Metiri, 2003) and for economic prosperity needed for the 21st century. Inventive Thinking, is defined as "an ability to effectively solve non-typical (creative) problems in various domains avoiding a large number of trials and errors" (Sokol, Oget, Sonntag & Khomenko, 2008, p. 34) and in the process it executes both convergent thinking and divergent thinking. Barak and Zadok (2007) argue that, as an ability for solving a problem, Inventive Thinking (or Inventive Problem Solving), is comprised of a set of complex, yet not limited to, internal processes that involve the utilisations of knowledge explicitly such as conceptual, procedural, factual and metacognitive knowledge; intuition; a mixture of ordered and disordered thinking, and all of these are influenced by cognitive and affective factors (Barak & Zadok, 2007).

Accordingly NCREL and Metiri (2003), identified the competencies of each practical inventive thinker's habits of minds, or dispositions, into four linear levels of progress namely (in ascending order) Novice, Basic, Proficient and Advanced. Additionally, to better understand Inventive Thinking, NCREL and Metiri (2003) have divided it into six dimensions, namely, Adaptability/Managing Complexity, Self Direction, Risk Taking, Curiosity, Creativity and, Higher Order Thinking and Sound Reasoning. Each dimension is then further divided into a number of sub-dimensions which distinctly address behavioral, cognitive and affective qualities of Inventive Thinking. As a result, there are efforts to develop teaching and learning programme that can embolden students' ability in thinking inventively.

Even though the quality of being inventive is a trait that has been natural to the survival of human being since in the past millennia (Moseley, Baumfield, Elliott, Gregson, Higgins, Miller, & Newton, 2005), it is still very important to recognise Inventive Thinking in the needs for today's and the near future's environment. In relation to this, empowering Inventive Thinking amongst students has always been a focus in and natural to the Science and Technology curriculum by means of teaching problem solving methods and their procedures in the subjects; pertinently in this era of technology and knowledge-based economy. Barak and Mesika (2007), amongst others, reported that by teaching students "a range of inventive principles" in the form of heuristics in a course comprising of 15 two-hour sessions, students' Inventive Thinking competencies, reflected through the quality of solutions suggested, had significantly increased as compared to their answers found in the pretest and of the students' in the control group. In another research, Barak and Zadok (2007) found that students, who underwent a two-hour per week robotic design programmed for 15 weeks, had gained benefits pertaining to the concepts in science, technology and problem solving by being able to show fluency in robotic design and building. To reiterate, these studies, amongst others, show how Inventive Thinking are empowered through the Science and Technology classrooms.

Levels of Inventive Thinking in Negara Brunei Darussalam had been researched before. In a

non-experimental study conducted by Abdullah and Osman (2010), it was found that the Bruneian students' mean scores (n=500) in the dimensions of Inventive Thinking were either at satisfactory or low level. It was reported that these students were at the satisfactory level in the dimensions of Adaptability/Managing Complexity, Self Direction, Risk Taking and Curiosity; and found to be low in mean scores in the dimensions of Creativity and Higher Order Thinking and Sound Reasoning (Abdullah & Osman, 2010). This research was conducted in the Science subject at the primary level, leading to a conclusion that the traditional classroom settings were to be blamed for the results.

However, there has been an increased awareness to teaching Inventive Thinking or Inventive Problem Solving in other learning areas such as in the language classrooms. For instance, Sokol *et al*. (2008) reported that students in the English as a Second Language subject who were learning in the environment of Thinking Approach classrooms for five hours per week for nine months recorded a significant increase in the competencies of Inventive Thinking, t = 3.32, p = .001, n = 54. In another study, Omar Ali (2014) reported that, Malay Language students in one of the experimental groups (n = 17), contrary to the findings of Abdullah and Osman (2010), had significantly improved in the dimensions of Self Direction and Creativity; while in general, had better posttest mean scores at The Inventive Thinking Survey Form (Malay Language) over the students in the control group (t *(16)* = -2.47, p = .025; t = -2.22, p = .042). Not only that, although the t-test result was not significant (t (17) = .99, p = .33; n = 18), Omar Ali (2014) reported that the mean score for the control group showed a decline in value, thus revealing that traditional classroom settings are not contributing towards the development of Inventive Thinking. In short, Inventive Thinking can be developed in any learning areas, as long as it incorporates in its teaching any form of systematic problem solving methods.

2. Methodology

Hence, this study aimed to (1) record and explore, that is by using a series of inferential statistical analyses by means of the Solomon Four-Group Design, of any shift in the participants' Inventive Thinking abilities and dispositions after the introduction of an intervention programme (Inventive Thinking Programme); and (2) give insights thus, to evaluate the 'effectiveness' of the developed intervention programme which was incorporated in the Bahasa Melayu classes.

This study is a quasi-experimental study; and it employs the Solomon Four Group Design. The samples in the study were divided into four groups namely Groups A, B, C and D. On one hand, all participants in Groups A and B received pretest and posttest, and on the other hand, participants in Groups C and D were only given posttest. In addition, those in Groups A and C, experimental groups, followed a 19-week intervention programme in their writing classrooms: 'Program Penyerapan Kemahiran Berfikir Inventif dalam Pengajaran Aspek Penulisan' (Inventive Thinking Skills Infusion Programme in Writing Classrooms) given by the researcher, while in contrasts, participants in the control groups of B and D underwent normal instructions under their current respective teachers. Both pretest and posttest were administered to all groups within the same time. The Solomon Four Group Design was

chosen for this study because the design (1) is "able to assess the presence of pretest sensitization" (2) and because of this sensitization, it offers "a higher degree of external validity in addition to its internal validity" (Braver & Braver, 1988, p. 150).

A total of 125 students from three different junior colleges in Negara Brunei Darussalam, namely JC1, JC2 and JC3 were selected for the study. JC1, all in Groups A and C (experimental groups), contributed the largest number of participants with 73 students. This is because it has the largest number of students enrolled in Bahasa Melayu at the pre-university level in the country at the time of this study. Meanwhile those in Groups B and D, consisting of 15 students from JC2 and 37 students from JC3, were pooled in the control groups. It is important to note that the differences in the number of participants from each junior college were as a result of the existing number of students taking the Bahasa Melayu at the Brunei Cambridge General Certificate of Education Advanced Level (A-Level).

Table 1. The frequency and total number of participants

	Group A	Group B	Group C	Group D
Male	7	11	16	11
Female	26	7	24	23
Total	33	18	40	34
Percentage	26.4%	14.4%	32%	27.2%

As mentioned, only participants in Groups A and C were given an intervention programme and it was conducted within the normal timetabling of Bahasa Melayu classes. The programme, which was conducted in Malay language, ran for 19 weeks and lessons time was fixed to one hour – one from the five hours scheduled to teach the subject per week – to emulate real classroom experiences in the infusions of teaching and learning thinking through the aspects of writing. It is also important to note that although allocations for each subject are five hours per week, in the case of Bahasa Melayu, the remainder are fixed for teaching and learning of other aspects of the language indicated in the curriculum.

The main objective of this programme was to empower the participants' Inventive Thinking ability and dispositions by means of exposing them to various critical and inventive thinking methods and techniques such as the two-step concept mapping using Post-It® notes, Formula for Identifying Contradictions, Advanced Systematic Inventive Thinking (ASIT) Tools and the concept of BAHARU: a set of tools for evaluation of solutions. Under the programme, participants were also given the opportunity to take part in a practical inventive activity of building an egg casings that would effectively protects the egg from any damages, if dropped.

Thus two quantitative instruments in the format of a quiz namely Kuiz Penyelesaian Masalah Inventif (Inventive Problem Solving Quiz) and a survey form namely Borang Kaji Selidik Pemikiran Inventif (Bahasa Melayu) or The Inventive Thinking Survey Form (Malay Language) were developed and administered in the study. The Inventive Problem Solving Quiz and the methodology to assess it were adapted from the quiz that was administered in Barak and Mesika (2007); while the survey form, which has 51 questions corresponding to the 47 sub-dimensions of the Inventive Thinking, was adapted and developed from The

enGauge 21st Century Skills Continua of Progress for Inventive Thinking (NCREL & Metiri, 2003). It was found that the Cronbach's Alpha for the 51-item survey form was highly reliable, that is, at .89.

The results from the instruments were then analysed statistically using The Statistical Package For The Social Science (SPSS) software version 21 and the analyses were conducted in accordance to the work flow suggested by Braver and Braver (1988) for the Solomon Four Group Design. At the final stage of data collection phase, focus group interviews were conducted with the objective to seek feedback and more information with regards to the programme.

3. Results

This study employed a quasi-experimental methodology and quantitative analyses which were conducted in accordance to the workflow suggested by Braver and Braver (1988). First to be discussed is the results from the Inventive Problem Solving Quiz. It was found that participants in the control groups (Groups B and D) recorded generally higher mean scores as compared to those who underwent the intervention programme (refer Table 2). To draw a conclusion upon this finding, a 2 X 2 ANOVA (or Test A in Braver & Braver, 1988) was first performed and yet the result was found to be not significant: F (1, 121) = .07, p = .80. Since there were no significant interactions recorded, a Main Effect test (Test D) then had to be performed. The result from the test was statistically significant F (1, 121) = 5.51, p = .02; thus according to Braver and Braver (1988), it was concluded that the programme has an effect towards the problem solving ability of the participants in the experiment groups (Groups A and C).

Table 2. Descriptive statistics for all groups from the Inventive Problem Solving Quiz (posttest)

	Groups	***Mean***	***S.D.***	***n***
Treatment groups	A	41.92	8.8595	33
	C	42.65	9.0004	40
	Total	42.17	8.8521	73
Control groups	B	45.81	6.2765	18
	D	45.77	5.7967	34
	Total	45.79	5.9054	52

Secondly is the results from the Inventive Thinking Survey Form (Bahasa Melayu). Results from the 2 X 2 ANOVA (Test A) for the mean scores of the four groups indicate that there was no significant interactions between the pretest and the treatment F (1, 121) = .04, p = .84. Similarly, a non-significant result was also obtained from Test D (Main Effect test), F (1, 121) = .31, p = .58. Thus, a Gain Score Analysis or Test F (One-Way ANOVA) was employed and the result was statistically significant, F (1, 49) = 7.54, p = .01, which indicates that the treatment has an effect at the experiment Group A (M=.16, SD=.3, n=33) as compared to the participants in the Group B (M=-.06, SD=.23, n=18). The result means participants in the experiment groups possessed positive outlooks towards solving a problem in contrast to the

participants in the other groups.

Table 3. Descriptive statistics for all groups from the Inventive Thinking Survey Form (Bahasa Melayu)

	Groups	***Mean***	***S.D.***	***n***
Treatment groups	A	2.72	0.2988	33
	C	2.64	0.2778	40
	Total	2.69	0.2923	73
Control groups	B	2.67	0.396	18
	D	2.62	0.3067	34
	Total	2.64	0.3374	52

In short, while the intervention programme contributed to the poorer performance at the quiz by the participants in the experiment group (M = 42.2, SD = 8.9), as compared to those in the control group (M=45.8, SD = 5.9), F (1,121) = 5.5, p = .02), interestingly, it was the experiment group who outperformed the other group in The Inventive Thinking Survey Form (M = 2.8, SD = .29, as opposed to M = 2.7, SD = .4; F (48, 1) = 5.9, p = .02). It is also concluded that, based on the results, there are no issues pertaining to pre-test sensitisation.

3.1 Findings from the interviews

Focus groups interviews were conducted six weeks after the post-test as it was not feasible for the interviews to be conducted immediately because participants were involved in examinations right after the programme concluded. However, it was beneficial for this study as participants can report their experiences in utilising the thinking skills during the examinations. Due to the limitations of the length for this paper, the main findings of the interviews are discussed and summarised as follow.

First, participants expressed that while the thinking tools, procedures and techniques were very handy at the times they needed to critically understand and creatively solve the problems presented to them in classrooms, or those that they encountered at home, they consistently reported that it was a challenge for them to apply the tools, procedures and techniques within the time limit in the examinations. In other words, while they were able to grasp the skills taught during the programme, participants were still not fluent or not highly competent in the applications of the skills especially while under pressure. Second, participants shared their views about the programme's structure and the time frame. Most students complained that the 19-week programme was short (if not too short) and the lessons time of the one hour lessons each week needed to be extended. One participant for instance mentioned that the one hour lesson was always not enough. She illustrated that in the lesson where a thinking tool (or a set of them) was taught, it was difficult for her to cope with the explanations and yet, by the time she started to understand them and was fully immersed into the lesson, the class was over.

Thus, from the interviews, suggestions were given as for the programme to be prolonged so that its structure is modified from as it was to, for example, a three-times-per-week programme in order for the theory- and practice-sessions to adequately be covered within a

week's time frame setting. There were also suggestions in regards to the time frame: participants voiced out that the programme should be taught at an earlier stage and suggestions varied from starting it in the first year of their pre-university schooling to even as early as from the primary school levels. Lastly, another *inventive* suggestion contributed by one of the participants is that, in terms of coverage and maximising the full potentials of the programme, it should be offered as a school-wide programme, and not restrict it to the writing classrooms only.

4. Discussions and Conclusion

This study has recorded and explored the levels of ability and dispositions of Inventive Thinking amongst pre-university students in Negara Brunei Darussalam. The findings from the quantitative instruments revealed that even though the participants' level in the habits of minds for Inventive Thinking in the experiment groups has significantly progressed as compared to those in the control groups, their performance in the quiz (in which the applications of Inventive Thinking in theoretical problem solvings were measured) is painting a paradoxical kind of imagery. This is in contrast to the findings reported by Barak and Mesika (2007) and Barak and Zadok (2007).

The question now is: how could one who possessed better dispositions towards problem solving did not perform better in the *act* of solving a problem? The answer lies at the complex nature of problem solving itself and the time for the participants to fully internalise it. As defined, Inventive Thinking is a form of problem solving which encompassed a set of complex internal processes. It was later revealed that from the interviews, participants who were given a treatment programme that aimed at empowering their Inventive Thinking have failed to apply the skills fluently in problem solving due to time constraints: when there was just not enough time for the participants to completely grasp and internalise the problem solving skills in the one-hour classes.

Though, it can be concluded that, while positive outcomes were established in the participants' dispositions thus conforming to the results obtained by Sokol *et al*. (2008) and Omar Ali (2014), the programme is not as effective as it should be as it does not improve participants' ability to solve problems fluently due to its shorter lessons time per session. Thus the immediate solutions to be considered are either first, to extend the lessons time for each session, at the least, to match the sessions from Barak and Mesika (2007), and Barak and Zadok (2007), or from Sokol *et al*. (2008), or second, to extend the coverage of the programme into other subjects by executing it as a school-wide programme. The latter, in practice, is more viable to be achieved as it is *easier* to be accomplished logistically in comparisons to extending the writing classrooms to two or three hours.

The findings from this study show how imperative the length of lessons time is towards the effectiveness of an Inventive Thinking programme especially when it is implemented and infused in a non Science and Technology subject. Finally, considering there is only one hour allocated for the teaching of Bahasa Melayu (or any other subjects) per day, alternative and inventive solutions such as extension of time or extension of programme coverage needs to be considered in the planning and implementation of future programmes.

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