CONCEPTIONS AND PRACTICES OF DIVERGENT THINKING AMONG FORM TWO SCIENCE TEACHERS

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CONCEPTIONS AND PRACTICES OF DIVERGENT THINKING AMONG FORM TWO SCIENCE TEACHERS

ABSTRACT

The purpose of this study was to investigate the conceptions and practices of Divergent Thinking among Form Two Science Teachers. Divergent thinking is integral to creativity which comprises four components, namely Fluency, Flexibility, Originality and Elaboration. Divergent thinking is important because it is the thought process that allows students to think outside the norm and to create many, original solutions for new problems. In our education system, it is the teachers' responsibility to foster divergent thinking in classroom as teachers are the main mediators between the curriculum and classroom practices. If the teachers lack conceptions on divergent thinking, they might unknowingly foster or suppress divergent thinking among students. The study was carried out based on three objectives, (i) to investigate selected Form Two science teachers' conception about divergent thinking; (ii) to investigate Form Two science teachers' practices of divergent thinking in science classroom; and (iii) to describe what are the gaps (if any) between Form Two science teachers' conceptions and practices of divergent thinking in science classroom. Three Form Two science teachers were selected based on convenience from three different secondary schools in Kuala Lumpur to participate in this study. The study utilized an exploratory qualitative research design. Data collection method involved interview sessions with teachers and classroom observations. An observation guide comprising of ten items based on four elements: Fluency, Flexibility, Originality and Elaboration was prepared. It was used as a framework to analyze classroom observation, discourse and conceptions by using Constant Comparative Method (CCM). Through the process of coding segments of interview texts and items from observation guide, ten categories were elicited. The trustworthiness of this study were ensured by Expert verification, Member Checking, and peer review. Findings of this study revealed that teachers do have some common conceptions pertaining divergent thinking; which were (i) many ideas, (ii) thinking out of the box, and (iii) producing uncommon or extraordinary outcomes. However, with only three teachers, their practices seem to lie along a continuum. Analysis of gaps showed that one of the teachers showed almost no gap as her conceptions and practices of divergent thinking were mostly parallel. On the other hand, the other two teachers have wider gaps, such as having the conception but unable to practice it, or vice-verse. According to the Theories-of-Action, when conceptions are not parallel as practices, problem would arise. Therefore, educational policies and teacher education programs should take steps to bridge the gaps if teachers are to successfully implement divergent thinking in the science classrooms.

KONSEPSI DAN AMALAN PEMIKIRAN MENCAPAH DALAM KALANGAN GURU SAINS TINGKATAN DUA

ABSTRAK

Tujuan kajian ini adalah untuk menyiasat konsepsi dan amalan pemikiran mencapah dalam kalangan guru sains Tingkatan Dua. Pemikiran mencapah merupakan sebahagian daripada kreativiti yang merangkumi empat komponen, iaitu Kefasihan, Kefleksibelan, Keaslian dan Penghuraian. Pemikiran mencapah penting kerana ia adalah proses pemikiran yang membenarkan pelajar berfikir di luar kebiasaan dan menghasilkan banyak penyelesaian yang asli untuk masalah baharu. Dalam sistem pendidikan kita, guru bertanggungjawab memupuk pemikiran mencapah di dalam kelas kerana mereka adalah pengantara utama di antara kurikulum dan amalan di dalam kelas. Sekiranya guru kurang memiliki konsepsi tentang pemikiran mencapah, berkemungkinan guru akan memupuk atau menindas pemikiran mencapah dalam kalangan pelajar. Kajian ini dijalankan berdasarkan tiga objektif, (i) untuk menyiasat konsepsi pemikiran mencapah guru sains Tingkatan Dua yang terpilih; (ii) untuk menyiasat amalan pemikiran mencapah guru sains Tingkatan Dua yang terpilih; dan (iii) untuk menghuraikan jurang (jika ada) di antara konsepsi dan amalan pemikiran mencapah dalam kalangan guru sains Tingkatan Dua . Tiga guru sains Tingkatan Dua dipilih secara persampelan mudah (*convenience sampling*) dari tiga sekolah menengah yang berbeza di Kuala Lumpur untuk turut serta dalam kajian ini. Kajian ini menggunakan bentuk kajian kualitatif eksploratori. Pemungutan data melibatkan sesi temubual dengan guru dan pemerhatian dalam kelas. Sebuah panduan pemerhatian yang mengandungi sepuluh item berdasarkan empat tema, Kefasihan, Kefleksibelan, Keaslian dan Penghuraian disediakan. Ia digunakan sebagai rangka untuk menganalisis pemerhatian dalam kelas dan konsepsi dengan menggunakan kaedah perbandingan tekal (*Constant Comparative Method*). Melalui proses pengkodan segmen teks temubual dan item daripada panduan pemerhatian, sepuluh kategori telah dikenalpasti. Kebolehpercayaan kajian ini dipastikan oleh pengesahan pakar, pemeriksaan ahli dan pemeriksaan oleh rakan. Dapatan kajian menunjukkan guru mempunyai beberapa konsepsi yang sama tentang pemikiran mencapah; iaitu (i) banyak idea, (ii) fikir di luar kotak, dan (iii) menghasilkan hasil yang luar biasa. Walaubagaimanapun, terdapat suatu kontinum dalam amalan guru. Analisis jurang menunjukkan salah seorang daripada guru tersebut mempunyai jurang yang kecil kerana konsepsi dan amalannya hampir selari. Dua guru yang lain pula mempunyai jurang yang lebih besar, seperti mempunyai konsepsi tetapi tidak dapat mengamalkan, atau sebaliknya. Berdasarkan *Theories-of-Action*, apabila konsepsi tidak selari dengan amalan, masalah akan timbul. Oleh itu, polisi pendidikan dan program pendidikan guru harus mengambil langkah untuk merapatkan jurang supaya guru berjaya mengamalkan pemikiran mencapah dalam kelas sains.

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LIST OF SYMBOLS AND ABBREVIATIONS

NEP	:	National Education Philosophy
TIMSS	:	Trends in International Mathematics and Science Study
PISA	:	Programme for International Student Assessment
HOTS	:	Higher Order Thinking Skills
KPM	:	Kementerian Pendidikan Malaysia
KSSR	:	Kurikulum Standard Sekolah Rendah
KSSM	:	Kurikulum Standard Sekolah Menengah
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
OECD	:	Organisation for Economic Co-operation and Development
IQ	:	Intelligence Quotient
ERIC	:	Education Resources Information Center
CFTI	:	Creativity Fostering Teachers Behaviour Index
CCM	:	Constant Comparative Method
DTA	:	Divergent Thinking Ability

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Here is a classroom scenario where first, a teacher provides the groups of students with materials, such as batteries, several types of liquids, citrus fruits, wires, rods made of different materials and light bulbs, and asks them to make the light bulb light by means of various ways they could think of using the materials given. Secondly, students are asked to design a model of a house and investigate how illumination within the house can be increased and consumption of electricity during day time can be reduced. This requires students to try possible factors that might affect the illumination in the house (such as the position of windows and lights, the colour of curtains and walls, the arrangement of furniture, height of the ceiling, shape of the house model). While having fun, the students' ability to play or hypothesizing with those factors while making the model of the house reflects their mind's flexibility and eventually provides space for unexpected, original ideas to surface.

Finally, students were asked to investigate and then come up with an explanation, on how each factors modified in the model house effects the lighting within the house. This requires creative formation of a theory to explain absorption and reflection of light; and usage of space. Here, students are given the opportunity to share their views and communicate ideas effectively while listening to feedback from classmates too. Students will have to elaborate how the different colours of walls and curtains, the space, windows and furniture placement does contributes to proper lighting in the house and also how it can be matched up perfectly in various ways. Of

course, adding up different variables here, such as daytime light during different seasons or limiting certain factors can elicit more innovative ideas.

The above scenario is how an ideal science classroom must be, a place for diversified ideas to emerge. Students have to be eccentric for a while to allow the new, uncommon ideas to come in to their mind. While it looks like only having fun, there is more to it, as it is essential to give rise to ideas that people normally do not think of while solving problem. The distraction of thinking wildly and making new associations is what brings the mind in the area of the unknown and unexpected, which is exactly what the future holds (Lovecky, 2004). In accordance to this, the ability to generate unusual, original, idiosyncratic responses for an open-ended task (Lovecky, 1990, 2004), and also the thought process that allows people to think outside the norm and to create new solutions (Robinson, 2005) is known as divergent thinking. Divergent thinking ability is seen as a crucial aspect for innovation and problem solving (Bijvoet-van den Berg & Hoicka, 2014) especially for ill -structured problems in science that promises successful advancements in science and engineering.

1.2 Background of study

Education in Malaysia is an ongoing effort towards further developing the potential of individuals in a holistic and integrated approach to create stable and harmonious intellectually, spiritually, emotionally and physically. National Education Philosophy was designed to produce Malaysian citizens who are knowledgeable, honourable, responsible, competent and capable of achieving well-being and contribute to the betterment of family, community and country (NEP, 1988).

Educational philosophies that guide all educational activities in Malaysia know as National Education Philosophy (NEP). With the advent of Stakeholder Forum, the

nation's education system actually shifts to position themselves ahead of the game with clearly expresses the basic principles and values that underlie and shape the Malaysian education system from the lowest level to the highest levels of the university. A basic concept is contained in the National Education Philosophy on the knowledge, values knowledge and the role of knowledge in human and community development. The value of knowledge lies in the truth content serves not only to inform and explain to the people that something, but more importantly the knowledge to influence, change and shape ourselves and human society (NEP, 1988).

In consonance with the National Education Philosophy, science education in Malaysia nurtures a science and technology culture by focusing on the development of individuals who are competitive, dynamic, robust and resilient and able to master scientific knowledge and technological competency. Aims of science education in Malaysia is to develop the potentials of individuals in an overall and integrated manner (NEP, 1988). The individual produced is believe to practice good moral values and has abilities to cope with the changes of scientific, technological advances and be responsible for the betterment of mankind.

Educational Development Plan for Malaysia (EDP) (2001 – 2010) stated that, the aims of secondary education is to enhance students' critical and creative thinking skills. By giving focus on science and technology, the prescribed curriculum by means will ensure production of workforces who are knowledgeable and skilful in various science and technology fields. Back then, the focus in the teaching-learning approach in the science curriculum in Malaysia at all levels is the mastery of scientific skills among the students (EDP, 2001). Since science subjects stress on inquiry and problem solving, therefore scientific processing and thinking skills became crucial aspects.

However, in the late 1990's and early 2000's International studies such as TIMSS and PISA began to pave a new direction for Science Education in Malaysia. Achievement of Malaysian students in TIMSS and PISA declined gradually in terms of scores and ranks to below average score in 2011 (OECD, 2015). To address this issue drastically, KPM has reviewed Education Blueprint to incorporate more problem-based learning and project-based learning in Science Education to nurture Higher Order Thinking Skills (HOTS). Thus, the new National Education Blueprint (NEB) (2013 - 2025) has been launched to ensure our students develop skills and competency needed for the 21st century. It emphasizes on inspiring divergent thinking aspect of creativity and fosters innovation (NEB, 2013).

New KSSR and KSSM syllabus offers an increased focus on higher-order thinking, however, the success of the new curriculum requires complex lesson delivery skills from teachers (NEB, 2013). Contrarily, UNESCO review (2012) reported that there was little evidence that teachers knew about or understood the implications for classroom practice of concepts fundamental to the philosophy and objectives of the curriculum. To tackle this, the second wave of the designed blueprint, intends to sharpen skills and abilities of teachers via professional development programs were launched.

However, there are no underlined measures to seriously focus on creativity of teachers to enable them to produce creative students. The case is similar for divergent thinking. Guilford's (1967) original conceptualization of divergent thinking skills has been retained in current creativity theorizing primarily in the four general categories, namely fluency, flexibility, originality and elaboration (Baer, 1993). Some profound scholars in creativity research, Torrance (1974), Wallach & Kogan (1965) and others, considered divergent thinking process as central to ones' creative process, and thus

divergent thinking ability were crucial to ones' creative ability. Most of these scholars focused on four of the divergent thinking skills; fluency (Guilford, 1967; Jung & Haier, 2013; Fink et al, 2011, 2010), flexibility (Guilford, 1967; Jung & Haier, 2013), originality (Guilford, 1967; Jung & Haier, 2013; Fink et al, 2011, 2010) and elaboration (Guilford, 1967). According to Baer (1993), creativity has come to mean divergent thinking because various divergent thinking theories have dominated creativity theory and research (Crockenberg, 1972; Heausler & Thompson, 1988; Kagan, 1988; Kaplan, 1990; Kogan, 1983; Mayer, 1983; McCrae, Arenberg & Costa, 1987; Rose and Lin, 1984; Runco & Albert, 1990; Torrance, 1972b, 1984, 1990).

Although divergent thinking is seen as vital thought process for creative problem solving in science (Rabari, Indoshi & Omusonga, 2011) which requires production of many solutions for one problem, we are yet to see programs designed to expose teachers on divergent thinking. Without the right conception on divergent thinking, teachers may not practice divergent thinking in class. This is supported by Creative Teaching Model by Palaniapan, (2008) which has four components; Product, Process, Person and Press. The Product and Process components involves four divergent thinking skills; Originality, Fluency, Flexibility and Elaboration. The model suggests that, the teachers' divergent cognitive Processes (Conceptions or Knowledge) will yield divergent teaching approaches (Practices) as the Product. The other two components, Person refers to teacher's personality as a creative person and Press refers to the learning environment. In this study, only the first two components Product and Process are relevant. Therefore, teachers' conception of divergent thinking and their practices in science classroom, has to be researched thoroughly and tackled accordingly in order to meet the aims of Education Blueprint.

1.3 Problem Statement

Divergent thinking is important for students of all level, starting from pre-school up to university. Past studies has shown that divergent thinking skills in childhood are important predictors of both personal and public achievement in later life (Runco, Millar, Acar, & Cramond, 2010; Sternberg, Jarvin, & Grigorenko, 2009).

Unfortunately, a study in Asian context, by Lau and Cheung, (2010) has revealed that there is a drastic drop in divergent thinking observed among Hong Kong students from grade 4 to 7 once they enrol in traditional school system. The drop was significant between grades 5 to 6, then continues up to grade 7. This study suggest that fluctuation in divergent thinking development generally occurs between transitions from elementary to high school from childhood to adolescence. Similar findings are reported by Lee and Choi, (2012) that indicates a downward trend in divergent thinking abilities among Korean high schoolers from grade 7 to 9. Such findings are supported by Hondzel and Gulliksen, (2015) that divergent thinking are components of learning that often go unmeasured due to standardized subject assessments and centralized examination in public education system that focuses on low level cognitive demands. While many systems of schooling around the world have claim to strive for creativity, historically students that exhibited creative predilections did not always make the best students. For example, Sir Thomas Edison, at the age of 12 was written off as school failures because his inability to conform to the acceptable way of thinking (Geist & Hohn, 2009). Due to this kind of scenario, most students are more likely to learn to conform to what is expected rather than fight to retain their divergent thoughts. Students are pressured to conform to a one-size-fits-all learning model by following rules without asking "why?" focusing on repetitious tasks without having their mind wander, and completing the masses of worksheets and assessments that are a constant

part of the day. Eventually, this may lead students to become incompetent in solving new problems that requires new solutions as they are not trained to think divergently.

Teachers pressure students to conform as many teachers may not have the idea that divergent thinking is an essential aspect in constructing knowledge. Without having the knowledge of creativity and divergent thinking precisely, teachers are unable to foster it effectively in classroom (Konstantinidou, Zisi, Michalopoulou, 2014; Kampylis, 2009). Teachers often emphasize learning by authority and acceptance of information simply because it is taught (Aljughaiman & Mowrer-Reynolds, 2005, Rashimah, 2012; Roy, 2012). Those requirements has slowly discourage students to grow up as divergent learners. Besides that, time restrictions, academic priorities, educational mandates from local school boards all the way up to federal departments, the overwhelming requirements of testing and assessment, and lack of funding has partially contributed to the disappearance of creative activity from our schools (Persellin, 2007; Viadero, 2008). Moreover, the findings of a study conducted by Siti Hajar (2008) which aims to measure the level of divergent thinking of pre-service teachers found that low level of divergent thinking ability of pre-service teachers in the science program, has the potential to affect the process of teacher delivery of knowledge and practice of divergent thinking in the classroom later. This evaluation on pre-service teachers was done based on the four divergent thinking components, which are originality, fluency, flexibility and elaboration and not convergent thinking ability such as IQ test.

The issue of diminishing divergent thinking in the classroom could be from a lack of knowledge on the subject among teachers (Roy, 2012). A study conducted in Hong Kong proved that most teacher education programs have neglected the training of teachers on methods of fostering divergent thinking in both general teaching and

specific teaching areas (Cheng, 2001). Given the fact that science teacher preparation programs do not include divergent thinking as a characteristic to be considered when planning and implementing instruction, or even as a general topic, it is not surprising that science teachers do not have enough information or expertise to approach highly divergent students in a way that best meets their needs (Morgan, Latham & Shifflet, 2009).

It may be that is why, teachers conception about divergent thinking is said to be more in the realm of a behaviour problem or a classroom management issue when they face divergent students in class. These student's ideas are often degraded by teacher's criticisms or avoidance (Westby, 1995) because divergent thinkers are different in what they think about, and how they express this difference. Teachers are unable to accept students who often confronts ideas, and cannot accept authority (Lovecky, 2004). This scenario make teachers find divergence, or in other words, creative characteristics in children to be distracting, consuming time for unnecessary questions and opinions, hard to manage (Fletcher, 2011), and eventually tries to discourage it because they failed to realize it is a prerequisite for divergent thinking. Instead of looking at it as an opportunity to encourage freedom of expression of ideas, teachers had neglected it. Besides that, teachers may be limiting divergent thinking by the rigid environment they construct in the classroom too (Westby & Dawson, 1995). For example, a study conducted by Feldhusen and Treffinger (1977) found that the teachers who agreed that class time should be spent on encouraging divergent thinking, turn out to possess a drastically different expectation of divergent traits from the students. Furthermore, teachers do not always define divergent thinking in the same manner as researchers, for example, teachers often view divergent thinking in terms of

writing and art, and they do not perceive it as a process of thinking and processing information (Bolden, Harries & Newton, 2010)

There is a difference between what researchers have found regarding divergent thinking and what teachers believe they do to promote it (Fletcher, 2011). According to Newton and Newton (2010), today's world requires more divergent thinking skills than have been needed in the past due to ever increasing technology, yet many educators do not alter their teaching plans to address the need to foster divergent thinking. This case happens to be true because, since science teachers are not trained in the area of divergent thinking, they may unknowingly discourage it. If divergent thinking is not encouraged or even acknowledged, as a long term effect, students who are highly divergent may be compliant to the expected, accepted behaviours and choose to suppress their divergent tendencies through the normal course of the school day. In some cases, teachers believe that they are encouraging divergent thinking in their teaching practices, but the reality is not (Newton & Newton, 2010). Thus, there lies a need to investigate to what extent, teachers have the knowledge and conception on divergent thinking in todays' teaching process.

According to Newton and Newton, (2010) and Beghetto, Kaufman and Baer, (2014), teachers often believe they are fostering divergent thinking by allowing students to draw pictures and work on projects, but in reality, divergent thinking is a line of thinking process (convergent and divergent thinking) that requires a great deal of attention to develop it to its fullest potential. A point to be noted by all teachers, that divergent thinking in the classroom context must be conceptualized differently from the way it is conceptualized among scientists. Wonderful idea does not necessarily look wonderful to the outside world, but as long as it has not occurred in other people's

mind yet, meaning that it has to be novel and original, fresh from the student's mind (Duckworth, 2006).

Furthermore, Malaysian students, generally has high respect towards teachers and are very obedient. Studies undertaken in the Malaysian context propose students' socio-cultural backgrounds as the reason for this situation (Nurjanah & Thang, 2013). Studies suggest that society nurture its members to respect teachers and teacher-centred learning is very much favoured (Thang et.al, 2011). They were trained from small to listen carefully what teacher says, and follow them attentively, as those teachers are regarded as the prime contributor to their success. Thang (2009) suggested the possibility that this phenomenon is caused by the spoon-feeding culture predominant in Malaysian schools and the influence of the Asian cultural values and outlook. Due to this phenomenon, teacher-centred teaching and learning of science has been focused on rote memorization of science fact by repetition and drilling (Rashimah, 2012). Such situation eventually discourage students to diversify their thinking and inhibits them from becoming creative problem solvers. As students become more self-critical (Thang, 2011), we risk losing our solvers of the unique problems of tomorrow in scientific field by what is mislabelled or suppressed today.

In order to follow what is suggested in our science curricular specification and other related documents, some teachers have taken the initiative to integrate problem-based or project-based learning in their lesson. Surprisingly, the whole class were able to submit similar projects or familiar solutions to a given problem because the teachers exposed problems or projects that is too common to the students and its' solution is well written in the internet. In a study by Geist and Hohn, (2009), teachers admitted that they did not create the activity for students but took it from other sources that are easily available. In this case, the teacher and students were both praised by the school

authority for their effort in upholding the curricular requirements. Such prolonged culture in schools has resulted in poor scores on creative problem solving section in PISA 2012 science assessment by Malaysian students (OECD, 2014) which definitely requires divergent thinking ability.

Suppression of creative ideas of students by the teachers' standardised requirements or internet-dependent projects has hindered students from being divergent learners. Their thinking have been confined by relaying 100 percent on the input provided by teachers in classroom (Thang, 2009, 2011) and looking up into the net for ready solutions. The impact of teacher's poor practice of divergent thinking throughout students' schooling days will be reflected on the students' performance even after they enrol in universities. Research has proven that only small number of Malaysian university students today are able to solve open-ended problem creatively and majority cannot because of their inability to think divergently (Johari et al., 2013). Further research conducted by Gayon, (2008) and Johari et al., (2013) also found that students' performance in problem familiarity shows that the students lack in exposure to word and open-ended problems, where fluency, flexibility, originality and elaboration which are components of divergent thinking seems to be obviously lacking. The reason our students are unable to state and elaborate observation or ideas deliberately is because their way of thinking is not diverse, and they have grown up by trying to conform to the teacher's way of doing things in favour of getting good grades and praise during school days.

Additionally, the science curricula used in national schools does not provide much free space for students to have time to carry out discussions, debates, projects or open-ended investigations (Johari et al., 2013) that is necessary in nurturing students to be divergent thinkers. Teachers often rush to complete the syllabus which underlines

too many learning outcomes (Rashimah, 2012). Here, the students' freedom of expression of ideas, freedom of questioning and experimentation and opportunities to explore with material during science lesson are often neglected due to time constrain (Dhingra & Sharma, 2015).

In the process of nurturing more competent learners in future, teachers need to understand how important it is to support divergent thinking in the classroom. How divergent thinking aspect of creativity is relevant in teaching is well described in David Starbuck's book "Creative teaching: Getting it right". Starbuck, (2006) reports that one of the biggest changes that took place in the 20th century was the nature of the workplace where outcomes of schooling are now more focused on transferable skills than on academic knowledge. Teachers should encourage students to think outside the box and come up with off the-wall ideas, which are the components of divergent thinking. But, students must be confident with the acceptation of those ideas by teachers before they are willing to voice such suggestions, and teachers must be confident that they can "bring the class" back if the flight of fancy go too far (Longshaw, 2009).

A child's creative expression, may be either stimulated or inhibited, depending on the attitude and expectations that teachers place on the creative behaviour of their students (Sharma, 2015). Academically creative thought should be the goal of all teachers. Moreover, creative problem solving in math and science are directly related to creativity in terms of divergent thinking (Geist & Hohn, 2009) and students with divergent thinking ability are said to be able to perform better in creative problem solving (Rabari, Indoshi & Omusonga, 2011). Therefore, a research on investigating form two science teachers' conception of divergent thinking and how do they practise divergent thinking in science class will provide an insight of how teachers' conceptions

will mould their practices. Even though researches on students' divergent thinking ability, teachers' conception and classroom practises concerning divergent thinking has been done, but it was done separately by different researchers involving different samples or participants (Salwa Mrayyan, 2016; Shi.et.al, 2017; Soh, 2016). Therefore this research will conveniently fill in the existing gap in research topics.

1.4 Research Objectives

Based on the problem explained above, three research objectives have been formulated. The objectives are:

1. To investigate selected Form Two science teachers' conceptions about divergent thinking

2. To investigate Form Two science teachers' practices of divergent thinking in science classrooms

3. To describe what are the gaps (if any) between Form Two science teachers' conceptions and practices of divergent thinking in science classrooms

1.5 Research Questions

Three research questions used to guide this research are:

1. What are the selected Form Two science teachers' conception of divergent thinking?

2. How are the Form Two science teachers' practices of divergent thinking in science classrooms?

3. What are the gaps (if any) between the selected Form Two science teachers' conceptions and practices of divergent thinking?

1.6 Operational Definition of Terms

1.6.1 Conception of Divergent thinking

Conception means the way in which something is perceived or regarded; understood; and the ability to imagine. It also means how does an idea of something is formed in one's mind. Divergent thinking refers to the individual's ability to produce diverse, unique, or unusual ideas when prompted with an open-ended question or activity (Runco, Dow, & Smith, 2006). Divergent thinking typically occurs in a spontaneous, free-flowing manner, such that the ideas are generated in a random, unorganized fashion. As introduced by Guilford (1967), divergent thinking components are Fluency, Flexibility, Originality and Elaboration. In the context of this study, researcher investigates what are Form Two science teachers' conception on divergent thinking in general and within the concept of science. Teachers' conception will be probed through semi structured interview session.

1.6.2 Practise of divergent thinking

Practise means the actual application or use of an idea, belief, or method, as opposed to theories relating to it (Oxford, 2019). In this study, practise refers to what teacher does in class to encourage divergent thinking.

This includes the activity planned by the teacher, questioning techniques, feedback, scaffolding, classroom discussion and encouragement. For example, the teacher's response on students' ideas, providing them opportunity to share opinions in class, and encouragement given to students to generate many ideas as possible. Teachers' practises will be observed and probed further via interviews after each lessons to gain deeper understanding on teachers' practices of divergent thinking in science class.

1.6.3 Form Two Science Teacher

In the case of this research, Form Two Science Teachers are the teachers who are currently teaching KBSM Form Two Science syllabus in Government Secondary Schools (SMK) within the vicinity of Kuala Lumpur. This teachers may be also teaching science to students of other levels in their respective schools.

1.7 Significance of Study

1.7.1 Significance to Teachers

Teaching profession has becoming more challenging day by day in order to produce future man power who are equipped with 21st century skills at workplace. Teachers are urged to feature divergent thinking in science classroom in order to tackle those challenges (Gallavan & Kottler, 2012). Birjandi and Bagherkazemi (2010) believe that teachers' thinking and content knowledge is highly intertwined with teachers' pedagogical success. Hence, teachers' understanding of divergent thinking must be clear before they can encourage their students to think divergently.

Therefore, there is a need to investigate teachers' conception of and practises of divergent thinking in science classes. This may provide an idea of how divergent thinking ability among students can be gradually improved through successful pedagogy which could be designed in future. Besides that, the finding of this study may also be used to address the need of trainee teachers as well as in-service novice and experienced teachers by including a topic on divergent thinking in their pre-service teachers' course syllabus or in-service teachers' Continuous Professional Development programs (CPD).

1.7.2 Significance to Students

Divergent thinking is important for students of all level, starting from pre-school up to university. Past studies has shown that creativity and, in particular, divergent thinking skills in childhood are important predictors of both personal and public achievement in later life (Runco, Millar, Acar, & Cramond, 2010; Sternberg, Jarvin, & Grigorenko, 2009).

Therefore, divergent thinking must be adequately support by teachers, especially in secondary schools. This is because, a child's development of divergent thinking ability is at the peak during their mid adolescent period due to their brain's development which is more likely to support greater flexibility for learning and creativity (Antink-Meyer & Lederman, 2015). Ability to act in creative ways is one of the most important "21st Century Skills" or competencies required by our students to thrive in modern society, regardless of nationality, owing to the ubiquity of technology, fast communication, and collaborative social networks (Bellanca & Brandt, 2010; European Parliament, 2006; Kay, 2010; Trilling & Fadel, 2009).

In order to produce creative and innovative future generation to compete in world job market, divergent thinking skills must be fostered in all content areas and in various ways throughout the school day, especially during the essential years of schooling (Newton & Newton, 2010) to enable them to grow up as a creative individual.

1.8 Limitations of the Study

Beyond the researcher's control, there could be few limitations in this study. The teachers (participants) in this study may not have been truthful while answering the researcher's questions at certain point during the interview.

Their answers maybe compromised to look good in front of the researcher, or they might have felt defensive to admit the truth. Another source of limitation could be teachers' inability to completely verbalise what is in their mind. Instead of elaborating some of their responses, they could have simplified it, trying not to drag on as they could not get the right word to explain. Besides that, at some points, teachers could have practiced superior lessons due to presence of researcher in the classroom.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discusses the literatures related to creativity in general and narrows down to divergent thinking. Theoretical and conceptual frameworks of this research were also discussed.

2.2 Selected Literature Review

2.2.1 Creativity

Creativity is generally defined as an ability to generate ideas and solutions that are both original (i.e. novel) and appropriate (Amabile, 1996; Kleibeuker, De Dreu, & Crone, 2013). Creativity is always called "thinking outside the box", and mostly regarded as an issue of how good your mental computers were (Gardner, 2010). According to Longshaw, (2009), creativity is about the ability to think, not just to recall, but to apply, suggest, extend and model it. Gardner (2010), in his *Five Minds for the Future*, has argued for the crucial role of creativity, as a one of the five cognitive abilities that leaders of the future should seek to cultivate. Often creative people seek opposition; that is, they decide to think in ways that counter tail how others think (Sternberg, 2006). This is because, even everyday scientific work such as problem solving, hypothesizing and modelling require imagination and creative thinking. We cannot deny that the civilized world we are living in today is a product of creative thinking of many individuals that have contributed to the development of new ideas and new ways of seeing reality in various field of study.

The idea that science is a creative endeavour is indisputable. Scientific ideas are creations of the mind and it is widely agreed that creative products must be both novel, appropriate and useful; and not simply random responding (Prabhakaran, Green & Gray, 2013). The invention of concepts and theories requires extraordinary imaginative leaps and aesthetic factors (Hadzigeorgiou, 2005). This means that scientific truth is not judged solely on the grounds that scientific ideas correspond to certain observable facts, but also because they contribute to a sense of wholeness (Bohm, 1988). Unification of time and space, the idea of simultaneity and that 'no two observers see exactly the same thing', were ideas that were common in both art and science where the "wholeness" can be experienced (Miller, 2001). Despite these similarities, the differences between art and science should also be stressed. In science, creativity and rationality always work together, and it is subjected to the process of verification, which does not exist in art. Scientific creativity is matched by rationality, with experiments playing a crucial role (Schwartz, Lederman, & Crawford, 2004). Scientific creativity never works without rationality and strict empirical testing.

The role of creativity in education is undeniable. According to ERIC database, over one million articles have been written about creativity in the contexts of education and learning. The fact that curriculum documents worldwide make explicit reference to creative thinking as a worthwhile goal of education reflects the great importance we attach to creativity (Hadzigeorgiou, 2012). Since science is one of the disciplines that can make a contribution to the achievement of this goal, therefore, supporting science students in the development of both their understandings about creativity in science and their creative abilities that is related to scientific practice seems intuitively essential (Hadzigeorgiou, Fokialis & Kabouropoulou, 2012).

Nowadays, the word “creative” or “create” is seen to be mushrooming everywhere in the field of education. For example, the Bloom’s taxonomy (1956) have been reworked by Anderson and Krathwal, (2001), and now the word “create” has been added at the top of its hierarchy which resembles the most complex form of human thinking. Educationist began to emphasize on “creative problem solving”, rather than just “problem solving” because future problems must be approached in an imaginative way to generate new, innovative and novel solutions. Unfortunately much of what we do in school concentrates, not on creating, but on remembering, understanding and applying (Wilson, 2016).

Moreover, there is empirical evidence that students do not appreciate the creative thinking required in doing science, and that they do not view science in general as a creative endeavor (Schmidt, 2011). This is somehow paradoxical, given that scientific knowledge is indeed the product of creative thinking (Osborne et al., 2003). Imagination, as a mental ability that has a close relationship with scientific creativity, deserves special attention. Slogans such as “creative science”, “creative problem solving” and “creative inquiry” may remain just slogans if we tend to identify creativity simply, with the generation of ideas without appreciating originality and flexibility of ideas and the role of content knowledge in elaborating creative thinking (Rowlands, 2011).

Creative thinking can be explained as a process of dual exchanges through the melding of two types of thinking, convergence and divergence (Guilford, 1967; Baer, 1993; Simon & Bock, 2015), where both are equally important**.** In creative production both thought processes are necessary as one first diverges ideas in numerous quantity, and then narrows and refines the array through convergent thought processes (Wilson, 2016). Specifically in creative problem solving, or in any complex problem solving

activity, one needs to be able to weave in and out of divergent and convergent thought patterns in order to effectively arrive at an appropriate conclusion specific for a given situation. However, too often the processes involved in schooling concentrate on convergent thought, and ignore or undervalue divergent thinking (Wilson, 2016).

2.2.2 Divergent Thinking

Guilford (1950), introduced the term divergent thinking and convergent thinking, which both thinking processes equally counts for creativity as whole.

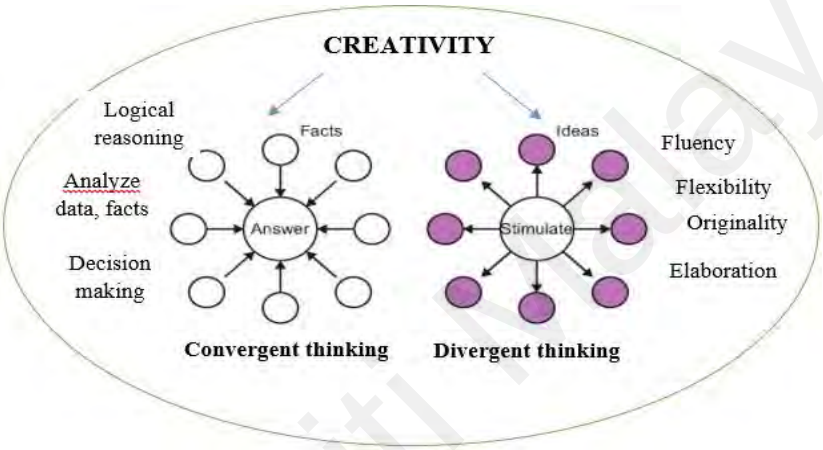

Figure 2.1 Convergent and Divergent thinking

Guilford's Structure of the Intellect Model (Baer, 1997) is a cubical model comprising three axis; Content (received and stored information), Operation (processed information) and Product (newly produced information) that enables researchers to understand human cognition. Under the Operation axis, Guilford, (1967) explained convergent thinking as using information stored in memory to obtain a single answer to a problem, whereas divergent thinking is to use information stored in memory to obtain many possible answers to a stimulus or problem. Unlike tests of convergent thinking, which require the individual to find one correct or conventional answer, divergent thinking tasks allow multiple answers and unusual ones to emerge (Runco, 2013).

Divergent thinking is defined as an idea-generating process wherein an individual is faced with problems or questions for which there is not just one answer (Guilford, 1950; Runco, Dow & Smith, 2006). Divergent thinking is the ability to elaborate and think of diverse and original ideas with fluency and speed. It occurs in a spontaneous, free-flowing, 'non-linear' manner. Divergent thinking is a fundamental skill for flexible thinking and creativity in brainstorming and ill-defined problem-solving tasks (Hayes, 1989; Newell, Shaw, & Simon, 1964). It is also characterized as 'less goalbound', freedom to go off into different direction, rejecting old solutions and striking off new direction (Getzels & Csikszentmihalyi, 1968). Besides that, divergent thinking is viewed as an estimation (Runco, 2010, 2011) or an indicator (Preckel, Wermer, & Spinath, 2011; Charles & Runco, 2001) of the creative potential which is important for innovation and problem solving especially for ill -structured problems in science (Bijvoet-van den Berg & Hoicka, 2014). Integrating divergent thinking into professional knowledge to create new ideas is of major importance too (Hsiao & Liang, 2003).

In a research by Palaniapan, (2008), he investigated one component of the thinking processes proposed by Guilford (1967), namely divergent thinking based on Rhodes, (1961)'s review on definitions of creativity. The review found that one of the aspects of creativity involves divergent thinking skills such as Originality, Fluency, Flexibility and Elaboration (Palaniapan, 1994). Besides that, Hommel et.al, (2012), Runco, (2013), De Caroli and Sagone, (2014), Antink-Meyer and Lederman, (2015), Brandon, (2016) and Chang et.al., (2017) have also used Originality, Fluency, Flexibility and Elaboration as the abilities or skills referring to divergent thinking in their respective studies. Therefore, in this study, researcher decides to follow those four components of divergent thinking; namely Fluency, Flexibility,

Originality and Elaboration to investigate teachers' conceptions and practices of divergent thinking.

According to Guilford, (1950, 1967), divergent thinking skills are fluency, flexibility, originality and elaboration. Fluency refers to number of responses (Beghetto, Kaufman & Baer, 2014; Guilford, 1950; Jung & Haier, 2013; Fink et al, 2011, 2010). It is the sum of responses received from a person. Fluency requires some knowledge, but it is not limited to reciting known ideas. With regards to fluency, Guilford (1950) stated that those people who produced large numbers of ideas were more likely to have significant ideas, while for flexibility, he stated that creative people should be able to change set easily, generate ideas from different perspectives and consider alternatives. Flexibility is the degree of difference of the responses, in other words, they come from multiple domains (Beghetto, Kaufman & Baer, 2014; Guilford, 1950; Jung & Haier, 2013). Flexibility includes thinking of many categories and considering multiple perspectives. For example, if a group of students list down importance of plants, such as to supply oxygen and as a major food source for herbivores, it still falls under same category (ecosystem). Students with higher flexibility may include ideas such as to increase country's revenue from agriculture and commodities export (economic), prevents constipation and traditional medications (health), production and usage of papers (industry and education) and many other. Unique ideas may not be readily recognized. Sometimes clarifying questions may be necessary to help students articulate and elaborate on their reasoning.

From the novelty aspect, Guilford states that divergent students would have original, unusual but appropriate ideas. Originality refers to the ability to create fresh, unique, unusual, new, or extremely different ideas or products through modification, creation, reconstruction, or designing (Beghetto, Kaufman & Baer, 2014; Guilford,

1950; Jung & Haier, 2013; Fink et al, 2011, 2010). For example, responses that were given by only 5% of sample group are unusual, and responses that were given by only 1% of the same sample group are said to be unique, which indicates higher divergent thinking ability.

Finally, the amount of detail given on the response is regarded as elaboration (Beghetto, Kaufman & Baer, 2014; Guilford, 1950, 1967). Elaboration it is the process of embellishing an idea by adding details to see how their ideas fit together, in other words, expanding ideas through increased details by adding up to make it more complex. Elaboration encourages students to expand their ideas and organize their thinking, as well as helping students clarify and articulate their thoughts. For instance, plants may *prevent constipation* (idea) as it contains *high fibre* (explanation) to *stimulate peristalsis* (explanation) movement. For teachers to support divergent thinking in their science classroom, teachers must teach key content and process skills while promoting long term understandings and not just isolated skills by using time efficiently to support extension after the learning (Brandon, 2016).

Divergent thinking was first described by Hargreaves (1927) and was further distinguished from convergent thinking by Guilford (1950) and Hudson (1968). Distinctively, convergent thinking, an equally important component of creativity, is typically associated with the analytical evaluation of ideas for the purpose of selecting best. Convergent thinking is defined as the ability to use logical and evaluative thinking to critique and narrow ideas to ones best suited for given situations, or set criteria. Divergent thinkers are novel thinkers, who can be exceptionally creative. This means that they do not first think of the common assumptions most others use in making decisions.

They think differently and have a real preference for unusual, original and idiosyncratic responses for open-ended task (Lovecky, 1990, 2004).

According to West et.al., (2012), number of empirical studies have shown that teachers can foster divergent thinking by providing opportunities that facilitates its emergence which is necessary to generate novel and useful ideas. In order to nurture our students to be divergent thinkers, their thoughts, impressions and feelings must be interconnected during science lesson (Lovecky, 1990, 2004). The students' diverse responses need to be valued, not being rejected straight away just because it is not listed in the answer rubric. Therefore, step-by-step learning, the type of learning expected in most schools may inhibit divergent thinking, simply because the material presented in science class makes no sense to them (Lovecky, 1990, 2004). This finding is similar to findings of Dhingra and Sharma (2015) that school system has a great influence on a child's creative expression, as it may either stimulate or inhibit, depending on the attitude and expectations that teachers place on the creative behaviour of their students. Teacher's practises in classroom plays a crucial role in promoting divergent thinking ability. Students need their ideas to be heard and evaluated fairly and given the freedom of questioning and experimentation and to explore new materials. This is because divergent thinking students may see different interconnections between the material and other material than does the teacher or classmates (Lovecky, 2004; Dhingra & Sharma, 2015).

In science education, we often hear about learning strategies such as authentic problem solving, inquiry based learning, project based learning and few others that claims to have contributed in scientific creativity. For there is also a crucial question: "how authentic inquiry based science can be in schools?" Are students really free to explore? Or are they somehow guided by their teachers to follow a step-by-step

procedure or recipe for inquiry (Asay & Orgill, 2010). The main flaw with inquiry science, as Kind and Kind (2007) have observed, is that the freedom and openness existing in real science is rarely achieved in the everyday reality of the science classroom, and, more often than not, teachers inevitably "frame" student inquiry and problems, by facilitating and providing most of what is required in the investigation.

There is some evidence, as they report, to argue that scientific inquiry does not offer any guarantee for fostering students' scientific creativity. In fact this evidence suggests that "any claims that "scientific creativity" is developed through inquiry science are certainly spurious" (Kind & Kind, 2007). In the context of school science, these two ideas should certainly be taken into account; first, science content knowledge is a prerequisite for thinking and hence a prerequisite for divergent thinking. Therefore, students should be highly knowledgeable about science. Second, science education should be about divergent thinking. Encouraging divergent thinking in the context of school science means encouraging idea generation in a non- threatening and critique-free environment. This means that, teachers need to provide the space and resources in order for students to be creative, all ideas need to be heard and not ridiculed, no matter how crazy they may sound (Di Trocchio, 1997; Hadzigeorgiou, Fokialis & Kabouropoulou, 2012; Lovecky, 1990, 2004). In conclusion, divergent thinking is grounded in knowledge, and therefore science teachers should help students to build content knowledge, but carefully "without killing it" (Boden, 2001). However, pessimistically, divergent thinking has been largely ignored and typically thought of as an all-purpose, creativity-relevant skill.

Often, divergent thinking scores based on four categories (fluency, flexibility, originality and elaboration) were summed up into a single creativity score (Kagan, 1988; Treffinger, 1986; Williams, 1980) which is found to be denying the importance

of divergent thinking in creativity (Baer, 1993). For example, most studies have claimed that training in divergent thinking have shown positive effect on creative performance by using divergent thinking test as their criterion (Rose & Lin, 1984; Torrance & Presbury, 1984). Such claims have been criticised because findings of those studies only implies that divergent thinking training has produced higher scores in divergent thinking test but not creativity as whole (Baer, 1993). To claim it as a creativity score, both divergent and convergent thinking test scores has to be taken into consideration.

Therefore, past researches where the findings were based on purely divergent thinking test scores were reviewed and included in the literature of this study as their findings directly correspond to divergent thinking skills. The focus of this study is only on the conceptions and practices of divergent thinking, which is a subset of the larger umbrella of creativity (Figure 2.1 page 21).

According to Cornish and Robert, teacher flexibility and acceptance of students are noted as the crucial determinants of a classroom atmosphere that promotes divergent thinking. The teacher concerned with divergent thinking attempts to set up problem situations for the students for which there is no one correct response, so that students can independently try out different solutions. Divergent thinking is more likely to thrive in an environment that allows for different types of expression, encourages risk and allows failure, reduced competitiveness, fearless students and open-minded teachers. Teachers may support divergent thinking in classroom by deferring judgment which includes both criticism and praise, encouraging the numbers by collecting every possible idea, supporting the strange, striving for the unusual and encouraging different perspectives and looking for combinations of ideas that might work together such as building off the ideas of others (Rees, 2010).

Table 2.1

Divergent thinking components

Divergent thinking component	Example (Runco, 2013)
Fluency	encouraging the numbers by collecting every possible idea;
	deferring judgment which includes both criticism and praise
Flexibility	encouraging different perspectives
Originality	supporting the strange, striving for the unusual
Elaboration	looking for combinations of ideas that might work together such as building off the ideas of others

Therefore, when teachers are observed and interviewed to collect data in this research, the criteria that is focused upon are how those teachers practices divergent thinking in science classroom by encouraging students to generate many ideas, possibilities and solutions (fluency), generate ideas from various perspectives (flexibility), share their own new ideas (unusual / original) and to effectively communicate their ideas for better understanding and to convince others of their ideas (elaboration). For instance, teachers may ask open-ended question for discussion (share your views on "having a triple decker bus in town" or "how does the usage of hot air balloon may affect traffic congestion during peak hours?") and accepts students' ideas that may or may not be practical. Teachers may encourage students to think from different directions of the circumstances that may arise due to this situation. Some answers from the students might be unusual and unique, so teachers plays an important role here in encouraging students' original interpretation and communication of ideas. Giving the students a chance to present their ideas in class or to apply their idea into practical task would be a great opportunity to develop divergent thinking ability.

2.3 Divergent Thinking Test

Divergent thinking tests are probably the most commonly-used assessment for creative potential (Runco & Acar, 2014). Divergent thinking is not synonymous with creativity but divergent thinking test scores do provide useful information about a person's creative potential. There are different ways to score divergent thinking tests (Acar & Runco, 2014; Hocevar, 1979; Hocevar & Bachelor, 1989; Hocevar & Michael, 1979; Milgram, 1990; Runco, Okuda, & Thurston, 1987; Torrance, 1995).

One of the prominent divergent thinking assessment test is the Alternative Uses Test developed by Guilford (1967). The test requires to think of as many uses as possible for a simple object, like a brick or a shoe or a paperclip and the test is usually time-constrained. This test measures divergent thinking, as it focuses for the generation of lots of ideas. Results of the test are measured across four sub-categories, namely Fluency (the number of alternative uses you can think of), Originality (how unusual those uses are), Flexibility (the range of ideas, from different domains) and finally Elaboration (level of detail and development of the idea). The scores of each sub-categories are independent, and shall not be summed up to a single score.

Torrance Test of Creative Thinking that was derived from Guilford's idea has two parts, Verbal and Figural test. The Verbal test measures Fluency, Flexibility and Originality, whereas Elaboration comes under Figural test together with Abstractness to Titles and Resistance to Closure. Finally, the average score of these abilities altogether is regarded as a person's Creativity Index.

Williams, (1991) developed a test kit called The Creativity Assessment Packet (CAP) comprising multiple instruments. CAP includes Williams Scale (rating instrument for teachers and parents of the same tested factors) and another 2 group-administered instruments, namely the Test of Divergent Thinking (Forms A and B),

Test of Divergent Feeling. Form A, known as "Exercise in Divergent Thinking" in Test of Divergent Thinking instrument measures Fluency, Flexibility, Originality and Elaboration and each of it are scored and interpreted independently.

Recent methods for the scoring of divergent thinking tests have employed computers. Acar and Runco (2014), for example, gave divergent thinking tests to a group of individuals via computer and then scored these tests using three semantic networks focusing on associative distance. Beketayev and Runco, (2016) scored Divergent Thinking Tests by computer with a Semantics-Based Algorithm (SBA). It compared the scores generated by the SBA method with the traditional methods of scoring divergent thinking for fluency, originality, and flexibility. Semantic basis of the SBA method follows from the theory that divergent thinking is unrelated to convergent thinking, but actual creative behaviour requires both divergent and convergent thinking (Cropley, 2006; Runco, 2013; Runco & Acar, 2012).

Those test discussed above were instruments to measure a person's divergent thinking ability, and not to measure practices or behaviours fostering divergent thinking. To be used in this study, an instrument to assess teachers' divergent thinking practices we derived based on Cropley, (2006) and Soh, (2000). Instrument by Soh (2000), Creativity Fostering Teachers Behaviour Index (CFTIndex) is a combination of behaviors by teachers to foster convergent and divergent thinking. Therefore, the researcher had carefully separate the divergent thinking behaviours to be used as a guide in this study.

After an extensive review of Cropley (1997) in a paper, Fostering Creativity in the Classroom: General Principles listed nine conditions necessary for teachers to foster student creativity as follow:

a) Independence: Encouraging independent learning of students

b) Integration: Facilitating co-operative and socially integrative teaching

c) Motivation: Emphasizing mastery of knowledge to enable divergent thinking

d) Judgment: Postponing judgment on students' ideas and encouraging them to more clearly formulate the ideas

e) Flexibility: Promoting flexible thinking

f) Evaluation: Encouraging students' self-evaluation

g) Question: Considering seriously students' suggestions

h) Opportunities: Creating opportunities for students to work under varied conditions with a variety of materials

i) Frustration: Providing a safety net to help students cope with frustration or failure

Soh, (2000) operationalized these nine principles in terms of teacher–student transactions to develop the Creativity Fostering Teacher Behaviour Index (CFTIndex). This CFTIndex is a six-point scale (ranging from 6-*All* to 1-*Never)* survey form and it has been cited and used by many researchers for various purposes who investigated different aspects of creativity development (Edinger, 2008; Lee & Kemple, 2014; Hondzel, 2013; Manriquez & Reivera, 2005; Forrester & Hui, 2007; Belio & Urtuzuastegul, 2013; Olanisimi, Adeniyi, & Olawale, 2011; Olawale, Adeniyi, & Olubela, 2010; Soh & Quek, 2007; Dikici, 2013). In other words, if teachers demonstrate criteria listed in the CFTIndex, their students are likely to develop creativity (Soh, 2000). Considering the fact that creativity is a combination of convergent and divergent thinking, therefore, the selected items from CFTIndex that

denotes divergent thinking has been re-coded to be used in this guide to see teachers; practices of divergent thinking.

2.4 Theory That Supports This Study

People are designers of their own actions. Actions are designed in order to achieve intended consequences. Based on this belief, Argyris and Schon (1974) assert that people hold maps in their heads about how to plan, implement and review their actions. Argyris and Schon suggest that there is a theory consistent with what people say and a theory consistent with what they do. Therefore there is a distinction between two different Theories-of-Action, which are Espoused theory and Theory-in-use (Argyris, Putnam & McLain Smith, 1985) that will be used as the theoretical framework of this study.

2.4.1 Theories-of-Action

Theories of action determine all deliberate human behaviour. Theories-of-action was originally proposed for organizational learning, but recently many researchers have used this theoretical framework to explain the behaviour of teachers (Kane et al., 2002; Samuelowicz & Bain, 2002; Willis, 1993). In Kane et al. (2002), the researchers did a critical analysis on how some studies predicted teachers' practices by what the teachers had verbalized or written down (Fox, 1983; Menges & Rando, 1989; Singer, 1996).

According to Argyris and Schon (1974), generally, all theories are situational, and based on an underlying set of values, beliefs and assumptions that frame an individual's conception of the world, which include assumptions about desirable outcomes for a variety of situations. A practice is a sequence of actions undertaken by a person to serve others, who are considered clients. Each action in the sequence of

actions repeats some aspect of other actions in the sequence, but each actions are unique from one another.

The words used to convey what individuals do or what they would like others to think they do are known as espoused theory, whereas their actual behaviour is described as the theory-in-use. Theory-in-use exists as an implicit knowledge where people clearly exhibit a certain action but find it difficult to explain or acknowledge that action verbally. However, people are unaware that their theories-in-use are often not the same as their espoused theories, and that people are often unaware of their theories-in-use. In fact, some people do not even realize that they have performed a certain action until it has been pointed out to them (Smith, 2001).

> *"When someone is asked how he would behave under certain circumstances, the answer he usually gives is his espoused theory of action for that situation. This is the theory of action to which he gives allegiance, and which, upon request, he communicates to others. However, the theory that actually governs his actions is the theory-in- use." (pp. 6-7)*

Argyris (1980) suggests that effectiveness results from developing congruence between Theory-in-use and Espoused theory. Hence, if people are unaware of the theories that drive their action (Theories-in-use) and their espoused theory, incongruence between both may affect the effectiveness of intended consequences (preferred outcome). In other words, when what someone says and what they actually do differs, there forms a gap that will contribute to other problems (Sathasivam & Daniel, 2011)

When the actual outcome of the strategy used are same as the preferred outcome, then the theory-in-use is confirmed because there is a match between intention and outcome. This means that there is no gap between the espoused theory and the theory-in-use (Argyris, 1980). However, if there is a mismatch between the

intention and outcome, it means there is a gap between the espoused theory and the theory-in-use.

In this study, the researcher has interpreted teachers' conceptions on divergent thinking as the espoused theory because this was the mental map that the teachers could talk about when they were asked about divergent thinking. The teachers' conceptions comprises all their beliefs, knowledge, assumptions and ideas they had about divergent thinking. On the other hand, theory-in-use is the teachers' practices of divergent thinking in classroom, which includes actual classroom discourse and actions that the teachers executed. According to Roy (2012) and Morgan et.al. (2009), when teachers lack knowledge or has limited conceptions on divergent thinking, it will affect teachers' practices of divergent thinking in classroom. Therefore, the 'theories-of-action' for this study is shown below.

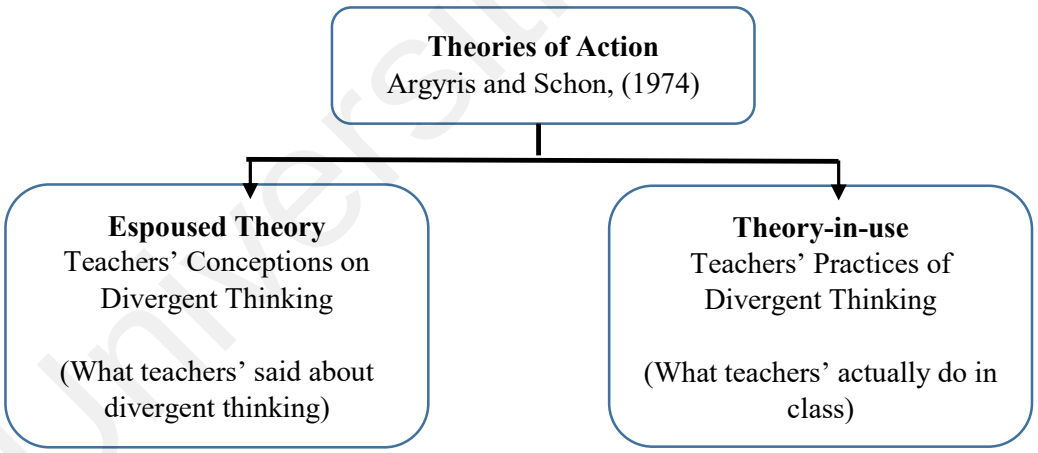

Figure 2.2 Modified 'Theories-of-action' used in this study [Arygris & Schön (1974)]

According to 'Theories-of-action' framework in Figure 2.1, preferred outcome can only be achieved if espoused theory and theory-in-use are congruent (Argyris, 1980). In this study, espoused theory is what the teachers think they know or they do (conception), whereas, theory-in-use is what the teachers actually do in classroom (practices). A teacher will be able achieve preferred outcome if she could put her all

conceptions into practices, in other words, the teachers' espoused theory and theory-in-use is parallel. When one or both of these were underdeveloped, it causes a gap between the espoused theory and theory-in-use. There can be three different situations when this gap can occur: first, the teacher's conception of divergent thinking is well developed but his/her actual divergent thinking practices are inadequate; second, the teacher's conception of divergent thinking may be underdeveloped but his/her actual divergent thinking practices are parallel with current theories and instruction; and lastly, both the teacher's conception of divergent thinking and practices are lagging.

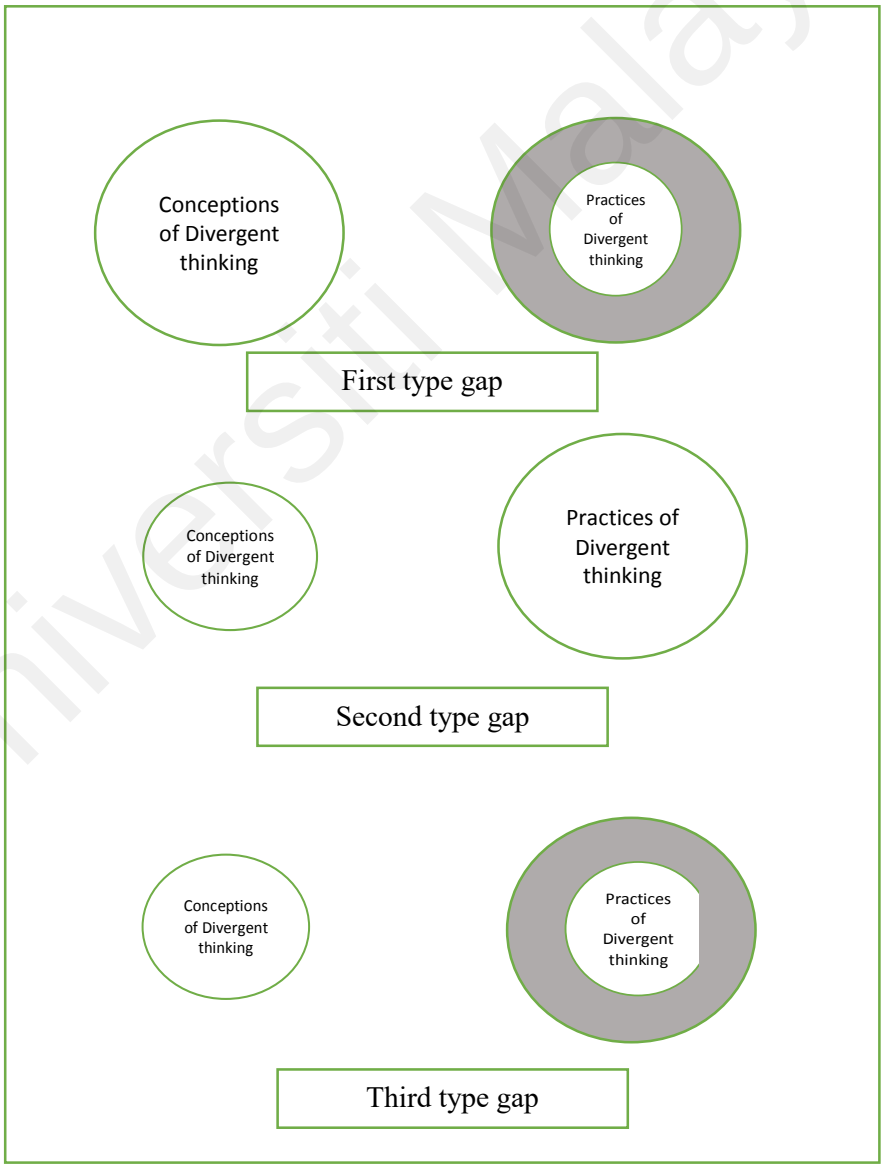

Figure 2.3 Graphic interpretation of gaps in teachers' conceptions and practices

Figure 2.2 shows the graphic interpretation of gaps (shaded regions) under various situations. The gaps need to be identified so that in future, the teachers can be made aware of their differences, and if these can be identified, perhaps teacher training programmes can be customised to address these problems.

2.5 Conceptual Framework

Based on the review of literature, it is found that numerous researches on various factors influencing divergent thinking has been carried out. Some of the researches can be grouped into few categories as shown in table below.

Table 2.2

Area of Research in Divergent Thinking

Learning tools / intervention	**Psychological (Behavioral / Mood / Experience)**	**Cognitive ability (academic achievement / IQ)**	**Teacher Factor (practises / conception / perception)**	**Demographic (age / gender / culture)**	**Development of DTA measurement instruments**
Hadzigeorgiou, Fokialis & Kabouropoulou 2012; Cheng, 2010; Geist & Hohn, 2009; Eason, Giannangeloa & Franceschini, 2009 Hasebe, Kawakami, Hiraoka & Naito, 2015; Yagolkovskiy & Kharkhurin, 2016; Suddendorf & Fletcher 1999	Yamada & Nagai, 2015; Cayirdag & Acar, 2010 Runco, Dow & Smith, 2006; X. Yi et.al 2015, Sannomiya & Yamaguchi, 2016 Feldhusen, Denny, & Condon, 1965; Wadia & Newell, 1963	Shi et.al., 2017 Pasztor et.al, 2015; Dhingra & Sharma, 2015 De Caroli & Sagone, 2014; Nusbaum & Silvia, 2011 Kuhn & Holling, 2009 Russo, 2004 Roue, 2011 Naderi et.al., 2010 Gluskinos 1971	Salwa Mrayyan, 2016; Soh, 2016; Goclowska & Crisp, 2013 Mullet et.al, 2016; Dhingra & Sharma, 2015; Roy, 2012; Morgan, Latham & Shifflet, 2009 Lee & Seo (2006) Palaniappan. A. K., 2008 Palaniappan. A. K., 1994	Kleibeuker, De Dreu, Crone, 2013; Simon & Bock, 2016; Palmiero, Giacomo & Passafiume, 2014; Y.-L.Chang et al. 2017 Dhingra & Sharma, 2015; Emam Moustafa Sayed & Ahmed Hassan Hemdan Mohamed, 2013; Kuhn & Holling, 2009	Prabhakaran, Green & Gray, 2013; Kaufman & Kaufman, Lichtenberger, 2011; Forthmann et. Al., 2016; Runco & Acar, 2014; Soh, 2000, 2007, 2015; Silvia, Martin & Nusbaum, 2009

Learning tools / intervention	Psychological (Behavioral / Mood / Experience)	Cognitive ability (academic achievement / IQ)	Teacher Factor (practises / conception / perception)	Demographic (age / gender / culture)	Development of DTA measurement instruments
Mengjing Ni et al., 2014 Thomas and Berk (1981)		Gralewski & Karwowski, 2012 Palaniappan, 2005; 2007a; Rashimah, 2012		Hondzel & Gulliksen, 2015, L. Vezzali et al. 2016 Roue, 2011 Palaniappan. A. K., 2011 Pannells & Rhoads 2005	

Based on table 2.2 shown above, can be seen that most of the creativity researches focusing on divergent thinking abilities has been carried out from the demographic aspect such as relationship between divergent thinking and gender. Previous researchers have shown keen interest to do further research in this gender because there are different aspects that can be researched upon gender. Furthermore, earlier studies have indicated that gender is one of the most significant and influential characteristics in academic achievement (Ai, 1999; Fennema, 1998; Habibollah. Et al., 2008; Naderi et al., 2008). Besides that, students' creativity based on divergent thinking scores and academic achievement is also been highly researched. Some researchers (Ai, 1999; Asha, 1980; Getzels, 1962; Karimi, 2000; Mohamad Taghi Mahmodi, 1998; Marjoribanks, 1976; Murphy & 1973; K. Yamamoto, 1964, 1964) found that there is a relationship between divergent thinking test scores and academic achievement; while other researches (Behroozi, 1997; Edwards, 1965; Mayhon, 1966; Nori, 2002; Tanpraphat, 1976) showed no such relationship in any significant way. The inconsistency in results of studies of the relationship between divergent thinking scores and academic achievement had set off a flood of investigations to understand

what the nature of divergent thinking was like because it has an important effect on psychology in the field of education (Naderi et.al, 2010).

2.5.1 Teachers' Conceptions and Practices

However, research on teacher factors are among the least that has been carried out. Research investigating the relationship between teachers' thoughts and actions showed a picture of great variability (Donche & Petegem, 2011). Some of the past researchers did investigate teachers' perception (Dhingra & Sharma, 2015; Tarmo 2016; Newton & Beverton 2012; Roy 2012) but inconclusive results were obtained from the analysis of data collected.

A systematic review of literature on creativity from 1999-2015 done by Mullet et.al (2016) found that although many teachers value creativity in terms of its' divergent thinking ability, their conception of it is ununiformed by the theory and research on creativity. The results obtained from past studies were inconclusive, as teachers' conceptions differs due to many factors such as subject knowledge, teaching experience and teaching styles (Lee & Seo, 2006; Bell, Lederman & Abd El Khalick, 2000). The problem is that, what counts for creativity or divergent thinking varies from subject to subject (Newton, 2012) and there is limited evidence of teachers' conception within a given a subject (Newton & Beverton, 2012).

To better understand why teachers teach the way they do, this study was carried out to advance current conception of divergent thinking among teachers and their actual teaching practises. This is because a teacher might or might not know what constitute divergent thinking generally. Teachers also need to know how to integrate divergent thinking skills within the context of lower secondary science syllabus in order to foster it and scaffold its development. Therefore this studies aims to investigate the conception of divergent thinking within the curriculum of science

because, to foster divergent thinking students, teachers need a clear understanding of what it is all about.

Moreover, within the online databases searched, limited research article involving science teachers' conception on divergent thinking and actual practise in Malaysia was found. Most of the research or reports found in Malaysia under the topic of creativity focuses on relationship towards academic achievement (Palaniappan, 2007, 2008; Naderi et.al., 2010, Siti Salbiah et.al, 2015), gender (Naderi et.al., 2010; Palaniappan, 2000) and cultural influences (Palaniappan, 2008). Mostly, quantitative data from students and teachers were collected, analysed and reported.

Since most schools in Malaysia often put the burden on teachers to encourage divergent thinking ability in students (Rashimah, 2015), therefore teachers' conception is seen to play a major role in fostering divergent thinking. In order to that, this research focused on interviewing teachers to obtain qualitative data on teachers' conception because implications for future research has indicated a need for qualitative research that seeks to explore teachers' conception of creativity, teacher particularly divergent thinking in depth as they relates to both the classroom context, teachers' backgrounds in education and training, and the overall discourse of creativity in education (Muller et.al, 2016).

Qualitative method is favoured in this study because dominance of quantitative methodology has been persistent for the past 10 years in the field of creativity by relying heavily on psychometric and experimental methodologies and cross-sectional studies which probably have led to a shallow understanding of creativity (Long, 2014). Hence, the focus of this study is to gain an in-depth and rich description of form two science teachers' conception and practises on divergent thinking.

Teaching students to think creatively has to be incorporated within the subject taught, and cannot be taught in isolation. Sometimes, what teacher thinks differs from what they do in class, (Roy, 2012). What is needed to be researched thoroughly is how the teachers make the students to think divergently. However, teachers who are unable to recognize and appreciate diverse ideas from students are prone to discourage it unknowingly.

Therefore, in conclusion, teachers' first need to have the right concept about creativity in terms of divergent thinking before they could encourage divergent thinking among their students relating to subject matter taught. Since most of the researches on divergent thinking were done in demographic context and less focused on teacher's support for creativity versus actual classroom practise, therefore there is room for such studies to be done in local context. Observing and identifying teaching practises that can be specifically applied and proven to be successful in promoting divergent thinking in science, is definitely crucial in order to improve students' ability to prosper in scientific field.

This study investigates teachers' conceptions and practices of divergent thinking in science classroom. Based on the theoretical framework of this study, teachers actions are determined by their conceptions. Teachers' own beliefs (Espoused Theory) affect their actions (Theory-in-use) in the classrooms because often the decisions that they make are based on their beliefs (Roth & Tobin, 2001; Samuelowicz & Bain, 2002; Schraw & Olafson, 2002). Palaniapan, (2008) has designed a teaching model based on Rhodes (1961) classification of creativity and the various divergent thinking dimensions of Guilford (1959). The model comprising four components, involved four divergent thinking dimensions in two of the components, namely Product and Process. The other two components, Person (teachers' creative

personality) and Press (learning environment factor) were not discussed further as it is irrelevant to this study.

The Process component represents teachers' cognitive processes, such as their conceptions, knowledge and beliefs. On the other hand, Product component refers to teachers' teaching actions, such as practices, approaches or strategies. Relating the model to this study suggest that, if the teacher has the correct conceptions of four divergent thinking abilities, therefore, the teacher will be most likely to practice it in his or her classroom effectively. Based on the literature review, teachers' thoughts and actions showed great disparity (Donche & Petegem, 2011; Mullet et.al, 2009; Roy, 2012). Therefore, the gap between teachers' conceptions and practices need to be identified in order to find ways to close the gaps in future.

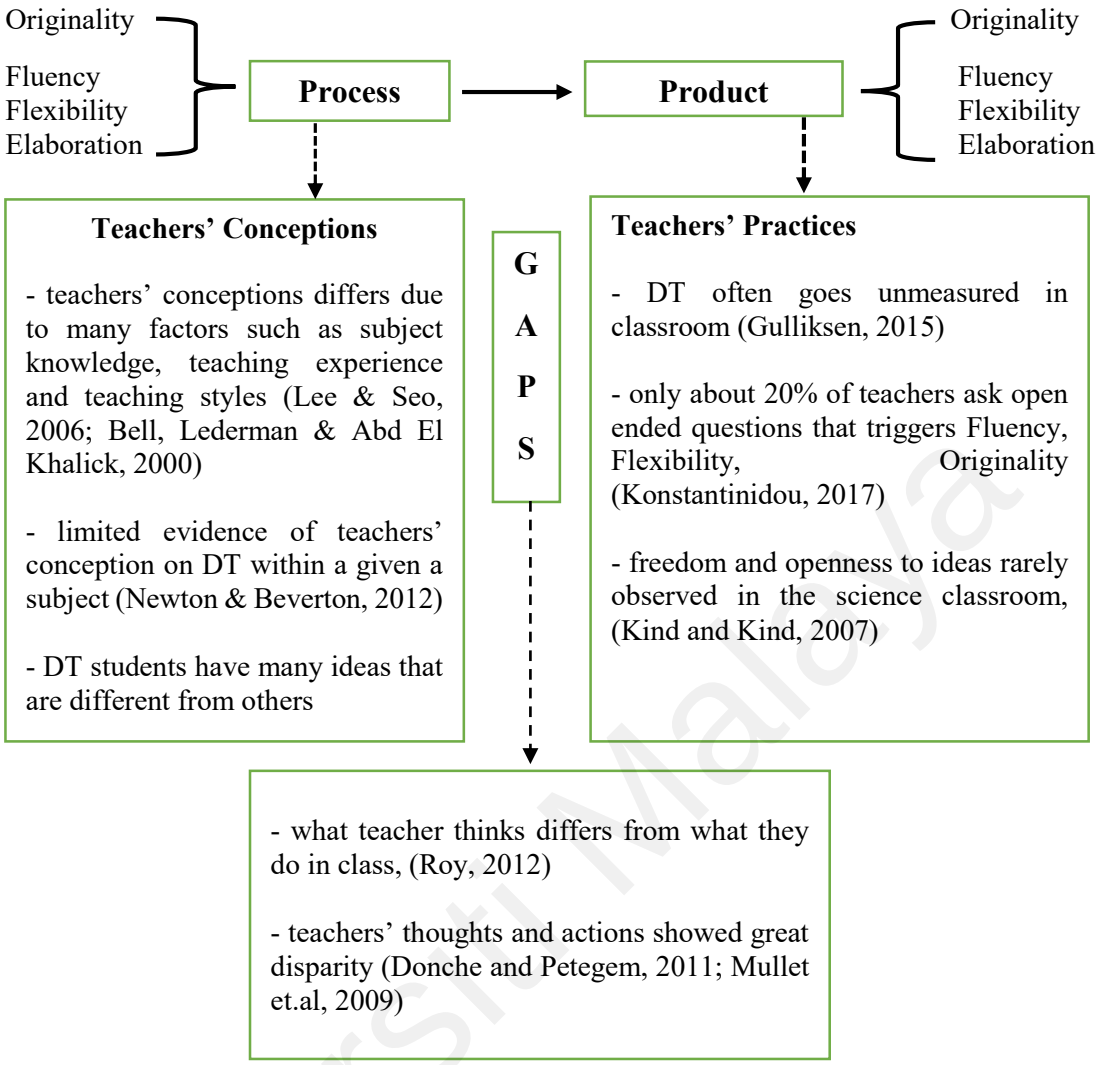

Figure 2.4 Conceptual Framework

2.6 Summary

This chapter starts from reviewing selected literatures relevant to this study, followed by discussion on theories and the designed conceptual framework that supports this study. Besides that, the relevance of using the intended instrument in this study has been explained too.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the research design chosen for this research, sampling technique, procedures, data collection methods, data analysis method. Besides that, description on construction of research instruments and validation has been included.

3.2 Research design

Research design used in this study is known as Exploratory Qualitative Study. Qualitative research can be valuable in elaborating existing knowledge or its applicability in specific contexts. The present small-scale, exploratory study employed a qualitative approach to investigate Form Two Science Teachers' Conception and Practices of Divergent Thinking in Science Classroom. It aims to identify teachers' conception, their classroom practices and the gaps between both if there are any.

Denzin and Lincoln (2005) describe qualitative research as study in their natural settings, attempting to make sense of or interpret phenomena in terms of the meanings people bring to them. Holloway and Wheeler (2002) refer to qualitative research as "a form of social enquiry that focuses on the way people interpret and make sense of their experience and the world in which they live". On the other hand, exploratory research is a methodological approach that is primarily concerned with discovery and helps us to have a better understanding of the problem.

It intends merely to explore the research questions and does not intend to offer final and conclusive solutions to existing problems (Saunders, Lewis & Thornhill, 2012). In this study, Exploratory Qualitative design helped the researcher to obtain

rich qualitative data by probing deeper and exploring the participants 'conceptions on divergent thinking.

3.3 Participants of Study

The best sampling method will always depend on the context of study and nature of research objectives. The participants of this research were selected based on their willingness to participate in the study and researcher's convenience to carry out observations.

The opted for convenience sampling because the researcher is a full time, morning session teacher. The researcher has got no authority or permission to carry out observations during working hours in other schools. Hence, the researcher can only choose afternoon session science teachers who are teaching science to form two students in government secondary schools within the vicinity of Pudu / Bangsar in Kuala Lumpur. The researcher has to opt for form two science teachers to be participants because the form one science syllabus has changed recently and the teachers may not have familiarize with the new chapters. Furthermore, the researcher has to find form two science teachers who are willing to participate in this study. Some of the teachers that the researcher approached earlier could not participate as they are not teaching form two students, some are teaching in single session schools where it will be inconvenient for researcher to visit during working hours, and two of them said that they do not want to participate

Putting together all the constraints and available choices, the researcher successfully found three participants who are teaching Form Two science and willing to participate in this study. All the teachers were from different schools, as the researcher could not find required number of teacher from the same school. They are

graduates from public university who have been teaching lower secondary science in national secondary school. Teachers were approached and explained about the data collection procedures which involves interviews and classroom observations and briefly about aim of the study. The researcher told the participants that they will be observed at their classrooms to personally collect the data to avoid sampling biases, as suggested by Mohd. Majd Konting, (1993). Furthermore, the researcher has also acquired the consent of the participants (Appendix F) to participate in this research and agree to the interview protocol and observation procedures as suggested by Ghazali Darusalam, (2015).

3.4 Data Collection Method

The research utilized qualitative data collection techniques that included classroom observation and interviews. Classroom observation were guided by an observation guide and the questions asked during the interview used an interview protocol.

Table 3.1

Data Collection Method

Research Question	Data Collection Method
What is the conception of divergent thinking among science teachers?	Interview
How are the science teachers' practices of divergent thinking in science class?	Observation and Interview
What are the gaps (if any) between teachers' conceptions and practices of divergent thinking?	Observation and Interview

3.4.1 Classroom observation

An observation guide has been developed via adaptation and modification from other valid sources to collect data for this research. The researcher has chosen to carry out classroom observation followed by open-ended interview at the end of each round of observation. Scheduled observation of teachers while they are teaching the same topic in their respective classes were done until saturation point is reached. Observation was done to observe how teachers practise divergent thinking in science class while audiotaping the classroom discourse. The guide was prepared by modification from Creativity Fostering Teacher Behaviour Indexs (Soh, 2000) which is attached as Appendix E. After modification, the devised guide were emailed to an expert, to check and verify the content of the guide meets the purpose (Appendix D).

3.4.2 Observation Guide

The original CFTIndex by Soh (2000) consist of 45 items divided into nine subscales as abovementioned General Principles by Cropley, (1997). Modification was done to it to fit the purpose of this research. Considering divergent thinking as a prominent component of creativity, the selected items in CFTIndex were re-coded base on four divergent thinking abilities; Fluency (FL), Flexibility (FX), Originality (OR) and Elaboration (EL) as in Appendix A. In the process of recoding, the items that was chosen to be placed under FL, FX, OR and EL were checked for its validity by referring to other similar researches that has used the same description for each components of divergent thinking.

For example, one of the chosen item under subscale of Frustration of CFTIndex is:

i) *I encourage students who experience failure to find other possible solutions*

This item was rephrased to *encourage students who experience failure to find other possible solutions* and placed under the category of Flexibility. It is consistent with other researches (Ozden, 2005; and Konstantinidou and Zisi, 2017) that also used this item to indicate promotion of Flexibility. Therefore, in this guide, the item was placed under the theme Flexibility. Another example would be one of the item under subscale of Questions of CFTIndex:

ii) *I follow up on my students' suggestions so that they know I take them seriously*

This item was rephrased to *follows up with when students suggest something* as suggested by Soh (2000) to be placed under the category of Elaboration because when teacher follows up, students are actually being probed for in-depth explanation.

All the item were converted from a Likert scale to an observation guide and sentences were rephrased. For example, *I encourage my students to give many suggestions* was changed to *teacher allows students to give many suggestions*.

Furthermore, some items that seems to be repetitive as it was originally a survey form, or has almost the same context, or could be observed simultaneously were combined to minimize the total number of items to facilitate observation. For example, *I provide opportunities for my students to share their strong and weak points with the class* and *In my class, students have opportunities to share ideas and views* were combined as one; *students have the opportunities to share ideas, views, and their strong and weak points with classmates*". Soh recommends to remove *strong and weak points* as it will be revealed while sharing ideas itself. So, the item was rephrased to *gives students opportunities to share ideas and views with classmates*. After modification has been completed, the observation guide (Appendix A) only consist of ten items to be observed. The CFTIndex developer has agreed and approved this usage to be valid (Appendix D).

3.4.3 Validation of Observation guide

Once the guide has been completed, it was emailed to the developer of CFTIndex, and he validated the content of the re-coded version can be used for this study to see teachers' practices of divergent thinking. He agreed to the re-coded version as the divergent thinking ability in behavioural terms are consistent with the item statements. He also checked the language and sentence construction of each items and corrected it. Then, the guide was double checked by an expert in science education, a senior science teacher in school, and also by a language expert, who is a Head of Language Department, in one of the secondary school in KL. All three of them agreed and validated the constructs and language of the guide and found it is suitable to be used to collect data without.

3.4.4 Interview Protocol

3.4.4.1 Interview

There were two sets of interview sessions. Firstly, interview session were held to gain the teacher's conceptions of divergent thinking. The data was collected using semi-structured interview protocol (Appendix C). Each teachers were interviewed once. The structure of the interview were adapted from prior studies. Protocol was prepared to ensure that the same basic lines of inquiry are pursued with each person interviewed and at the same time it can provide reliable, comparable, qualitative data on teachers' conception. The protocol provides topics or subject areas within which the researcher is free to explore, probe, and ask questions that will elucidate and illuminate that particular subject. Thus, the researcher remains free to build a conversation within a particular subject area, to word questions spontaneously, and to establish a conversational style but with the focus on a particular subject that has been predetermined. The protocol serves as a guide during the interview to make sure that

all relevant topics are covered. For example, teachers were asked, “what would you consider creativity as?” Researcher started questioning using a more familiar term “creativity” to see the teachers definition of creativity, whether the teacher is aware of divergent thinking component or not. From the teacher’s responses, the researcher propels further explanation until the teacher repeated the same answer, which means saturation has been reached. Then, researcher moved to the next question.

Another sets of interview sessions were held after each classroom observations. The interview sessions were open ended as the questions asked were related to what was observed during each lesson. All three teachers were interviewed 3 times atleast, after their each lessons. The purpose of such interview is to gain clarification and reasoning of their practices. Hence, all three teachers has the possibility of being asked different questions based on what they did during each lesson.

Although this study is about divergent thinking, the researcher decided to begin probing the teachers by using a more familiar term that is related to divergent thinking, that is creativity. The researcher would like to see whether the teachers have the conception that divergent thinking is a part of creativity, and from there the teachers can be probed deeper about divergent thinking. However if the teachers do not mention anything about divergent thinking in the beginning, then the researcher will still question them about it later on. Based on response given by teachers for each questions, the researcher asked for further clarification upon their conceptions on divergent thinking.

3.5 Procedures

First, participants of this research were identified. Selection was made based on the willingness of Form Two teachers to participate in this study. All three teachers were chosen from different public secondary schools in Kuala Lumpur and currently teaches science subject for form two students. All students will be taught the same chapter during the period of observation, Chapter 9 Stability. Considering that students' understanding of the knowledge content is a prerequisite for divergent thinking, thus this chapter is chosen because the fundamental concepts of stability are easy to be understood by students and there is a lot of space for teachers to foster divergent thinking if the teachers are aware of doing it. Since concepts are easy to understand, thus it provides more room for students to expand thinking into application of concept into different directions and generations of new, innovative ideas.

Before meeting the participants, the researcher has wrote in to the Research and Planning Unit under Ministry of Education to obtain approval for collection data from teachers in school. The approval letter is attached as Appendix G. The researcher went to respective schools two weeks before the scheduled observations to meet and brief them on the procedures of data collection. Teaches read, understood and signed the consent letter to willingly involve in this study and they are aware that they are free to withdraw from this study at any point if they want to. The researcher also requested for a copy of the teachers' class timetable to plan her visits to all three schools for observation without interruptions.

On the first day, the teachers were interviewed based on the interview protocol that has been prepared to probe teachers' conception on divergent thinking. Interview was carried out in their respective schools during their free periods in between classes. The teachers were given time to think for a moment of what they are going to say,

before the researcher began recording their answers. Teachers were also allowed to ask for clarification regarding the questions that was asked before they answer. Teachers were probed until saturation of data has been reached. All the teachers were interviewed before classroom observation commences.

While the teachers conducts the lesson, the researcher, who is a non-participating observer, was present in the class to observe the way the teacher carries out the lesson. The researcher takes down field notes and marks the observation guide while following the lesson. However, to avoid missing out any important points, the lessons were audiotaped with the teacher's permission. The recorder was placed at the front, on the teachers table because most of the time, the teachers' movement in classroom were inclined towards that area. During each round of observation, teachers were observed for about one hour (two periods), while taking notes and marking the observation guide based on teachers' practices in classroom. Those teachers were repetitively observed until the chapter taught is over. The duration of observation was about three times which took about two weeks for each teachers to finish the topic.

After each round of observation, the teachers were interviewed to further clarify teacher's practises on that day on why certain method were applied, why such remarks were given, what is the rational of carrying out particular activity and so on. Teachers were probed further until sufficient data has been acquired or saturation has been reached. The interview sessions were audio-taped.

3.6 Data Analysis

Data collected were analysed qualitatively. Inductive approach is used to analyse the data. The inductive approach is evident in several types of qualitative data analyses, especially grounded theory (Strauss & Corbin, 1990). Inductive approaches are

intended to aid an understanding of meaning in complex data through the development of summary themes or categories from the raw data ("data reduction"). According to Thomas, (2003), these approaches are evident in many qualitative data analyses. One of the may purpose of inductive approach is to condense extensive and varied raw text data into a brief, summary format.

Many qualitative studies collect audio or video data (e.g. recordings of interviews, focus groups or talk in consultation), and these are usually transcribed into written form for closer study. The data from the classroom discourse and interview sessions in this study were transcribed verbatim. The transcribed verbatim was given back to the participating teachers for member checking. A copy of transcribe has been attached as Appendix H. According to Lincoln and Guba, (1985), member check is the most important method in establishing credibility of research findings. Member check, or also known as respondent validation, serves to decrease the incidence of incorrect data and the incorrect interpretation of data. The overall goal of this process is to provide findings that are authentic, original and reliable. The finding of this research were analysed to determine common themes and differences of conception and practice among all participants using Constant Comparative Method (CCM).

Before the Constant Comparative Method can be used to compare and contrast, the sub-themes have to be decided. Therefore, the researcher applied open coding technique to look for distinct concepts and categories from the transcript to become the categories under the four main predetermined themes of divergent thinking, i.e fluency, flexibility, originality and elaboration. For examples, the first item under the theme fluency in the observation guide is to *allow students to give many suggestions / opinions (ask for more answers / ideas with open ended question / stimulus)*. Therefore, the category that has been formed for this item is "many ideas". Based on

the excerpt of teachers during interview, if they mention about many idea, a lot of suggestions or various ideas, then can be concluded that they have the conception. In this study, all the teachers mentioned "many ideas" with regard to divergent thinking. Hence "many ideas" is suitable to be placed under main theme "Fluency" because fluency is indeed the ability to give many ideas or responses. Open coding was followed by axial coding where experts and researcher's concept*s* were compared while re-reading the transcript. This is to confirm that the determined themes and categories accurately represent interview responses. For example the phrase "will always give their view" is accepted to be under the sub-theme "many ideas" because "view" is synonym to "idea" and "always" can be counted for "frequent". Giving frequent ideas will certainly contribute many ideas, hence the phrase can have the same meaning as "many ideas". Plus the teacher kept interchanging the term "view "and "idea" in her response, so can be inferred that she assumed both terms means the same.

Transcripts were read several times and compared with observation guide to create a matrix for each teachers, which will assist to identify mutual themes and categories. The researcher had predetermined themes, which are Fluency, Flexibility, Originality and Elaboration. From the raw data, words that matches the descriptions of predetermined themes were found to be consistent in teachers' practices. A complete list of predetermined themes and categories formed for each items were attached in Appendix B. Table 3.2 shows an example of the coding of items from the observation guide to form category for the theme fluency.

Table 3.2

Coding of Items from Observation guide

Themes	Items	Categories
Fluency (FL)	allows students to give many suggestions / opinions (ask for more answers / ideas with open ended question / stimulus)	Many ideas

As for practices, the teachers' practices in classroom that intends to trigger students to give many ideas, such as asking for more examples or suggestions, were placed under this category and theme too. The categories that were present in teachers' interview excerpts and seen in classroom were used to analyse conceptions, practices and underlying gaps. A matrix for each teacher in terms of conception and actual practices were created to facilitate the coding of segments of interview texts and items from observation guide as follows:

Table 3.3

Excerpt from interview and practices for each categories

Theme	Categories	Conceptions	Practices
Fluency	Many ideas	*Creative students asks a lot of questions because they have many ideas*	*T: name the sports where balancing is crucial* *T: well, give me more examples of objects in…. regular shape*

From the above example, it shows that the teacher has conceptions and practices of Fluency component of divergent thinking. A rigorous and systematic reading and coding of the transcripts allowed categories to emerge. Segments of interview text were coded enabling an analysis of interview segments on particular categories for audit trails. Similarities and differences across teachers' conception and practises were also explored.

3.7 Credibility and Trustworthiness of this study

In this study, the researcher built a rapport with the participants in order to obtain honest and open responses. During interview, the researcher restated and summarized information and then question the participant to determine accuracy of the information. After that, researcher has shown the raw interview transcript to the respective participant to check and agree that what has been transcript verbatim is that same as what has been said, as suggested by Creswell (2008) and Holand, (2002). Besides that, direct observation by researcher was done to increase reliability of data collection via observation as recommended by Liane (2000) and Meriam (2001).

An audit trail was done to establish the conformability of this research study's findings. Audit trails are an in-depth approach to illustrate that the findings are based on the participants' narratives and the data is analysed in a transparent manner without researcher's own preconceptions or biasness. For example, the excerpt from interview of Teacher Fiza is written as (Fiza, I1) which means the excerpt is quoted by Fiza during the first interview session. Another example is (Krsna, O2), which refers to Krsna's words during second observation. A list of codings used for audit trail are summarized in Table 3.4

Table 3.4

Codings for audit trail

Items	Coding
Participants	Pseudo names Fiza, Iza, Krsna
Interview	I ( )
Interview for Clarification	IC ( )
Observation	O ( )
Fieldnotes	FN ( )

3.8 Summary

This chapter has described the methodology for this study, namely the research design, participants involved, data collection methods, procedures, data analysis and the trustworthiness of this study. The following chapter reports the findings of this study, which are the conceptions and practices of divergent thinking and the gaps if any.

CHAPTER 4

FINDINGS

4.1 Introduction

The first two research questions probes into teachers' conception and practices of divergent thinking. Data on teachers' conception were obtained by interviewing them using a semi structured interview protocol whereas teachers' practices used classroom observation. The classroom discourse delivered were audiotaped to support observation guided by the guide and field note. Based on these data, Constant Comparative Method was used on the data obtained to see if there were any inconsistency (gap) about what teachers think they know, (conception) and what they actually do in class (practices). Therefore, the gaps between the two aspects (if any) will be also discussed thoroughly. Prior to reporting the findings further, a brief introduction of all three teachers on their personality and experience are presented.

4.2 Research Participants' Profile

The paragraph below describes the teachers' profile briefly. All three teachers, Fiza, Krsna and Iza hold a Bachelor's Degree in Education majoring in Science from local public universities. These teachers were all teaching Form Two Science in public secondary schools within a 6km radius among each other.

Fiza has teaching experience of eleven years. She had mastered the content of the syllabus and the assessment system over the years, making her an experienced teacher. This could be observed as she was able to explain concepts and examples confidently without looking at any books while teaching. The content in the book seemed to be already in her mind, because she had being teaching the same syllabus

for a long time. However, she had also limited the content of her lesson, to the extent of what is in the syllabus only. As a person, she was humble, easily approachable, and always attentive towards the needs of students. She would normally, at the beginning of the lesson, ask her students if did they bring the books or did they do the homework.

Krsna has 28 years of service. Despite having vast experience teaching other levels (forms) in other schools, she was well-versed of the current syllabus and the assessment system as she can immediately relate this chapter to another that the student have learned before. Moreover, she often informed the students' how PT3 questions may appear in the exam paper, where one questions may have connection with few chapters. Therefore she advised them to always look at the bigger picture when planning to answer any given questions. She portrays a motherly outlook, and is a very kind-hearted person. Students in her class do not misbehave and listens to her attentively, and so her students feel free to share their views and experiences when prompted. She provided a lot of opportunity for students to express themselves in a proper manner, and the students seemed to be lively throughout her lessons.

Iza has been teaching for four years. Although she was a young teacher, she seemed to be strict and slightly inflexible. Every instructions was given in a loud, monotonous voice. There were no jokes or poor sense of humour in her teaching, because students were serious throughout the lesson. This could be her way of controlling the class to ensure lessons were not distracted by other factors. Students in her class would be passive until told to do otherwise, as they were careful not to displease her. Iza strikes out as a person who was very concern with her students' achievement as she repetitively stressed on that part during each lesson. Overall, she was a dedicated teacher who consistently motivated her students to be high achievers.

4.3 RQ1: Teachers' conception on divergent thinking

Teachers' conception on divergent thinking has been categorised according to four themes following the four components of divergent thinking and eleven underlying categories to facilitate comparison. The same themes will be used to compare teachers' practices as well. A summary of the categories emerged under each themes through interview were shown in Table 4.1

Table 4.1

Categories emerged from teachers' conceptions

Themes	Categories	Teachers
Fluency	Many ideas	Fiza, Krsna, Iza
	Quick to respond	Krsna
Flexibility	Different direction	Fiza, Krsna, Iza
	Support for failure	Krsna
Originality	Generate new innovative idea	Fiza, Krsna, Iza
	Own experiences	Krsna
Elaboration	Present projects and communicate ideas	Fiza, Krsna, Iza
	Probe deeper	Krsna, Iza

A total of eight categories emerged while analysis the interview transcript of each teachers. Each emerging categories were listed with the excerpts.

4.3.1 Theme 1 - Fluency

Fluency is the ability of students to generate many answers or ideas in a given time. In this study, teachers' conceptions about divergent thinking in terms of Fluency elicited two categories: (i) many ideas and (ii) quick responses.

(i) Category – Many ideas

Fiza, Krsna and Iza knew that ability to generate many ideas was a prominent criteria of divergent thinking and all of them mentioned this when asked about their conceptions of divergent thinking.

"Creative students asks a lot of questions because they have many ideas…
"….. since they have many ideas, that's why they ask a lot [of questions] "

(Fiza, I1)

Fiza's conception about divergent thinking in terms of fluency, she feels divergent students already have many ideas or suggestions running in their mind, and they are always willing to give their ideas.

"students' are talkative, with various ideas that make sense"
"will give various ideas or suggestions to solve a problem"

(Krsna, I1)

Krsna mentioned various idea which means different kinds, of two or more things, and it seem to be similar with many ideas. According to Krsna, divergent students appear to be talkative in class because they have a lot to say, they have many different ideas just for one issue.

"….will always give their view"

(Iza, I1)

On the other hand, Iza thinks that creative or divergent students *"will always give their view"* ("view" is synonym to ideas). The term "always give" means giving a number of responses, hence, the phrase is synonym to many ideas.

(ii) Category - Quick Response

Besides *many ideas*, giving *quick response* is perceived as an equally important criteria pertaining fluency in divergent thinking. Only one teacher,

Krsna did voice out her opinion about it. For her, students' confidence and readiness to respond fast, knowing that it does not matter whether the answer is correct or not, is considered as fluency too.

"….and they are quick to respond with wise ideas…"

(Krsna, I1)

4.3.2 Theme 2 - Flexibility

Flexibility is the ability to think of many categories and considering multiple perspective. For the theme Flexibility, two categories emerged for the teachers' conception of divergent thinking. The two categories for the theme Flexibility were (i) Different direction or uses, and (ii) Support for failure. All three teachers had the conception that different direction or uses.

(i) Categories - Different direction or uses

Fiza and Iza had similar conceptions about divergent thinking as thinking of many ways to complete the task without depending on the teacher.

"…..it is about thinking out of the box, from creative ideas, creative products emerge"
"Able to think of many ways to complete the task given without depending on teacher all the time"

(Fiza, I1)

"Always look for another way of doing a task"

(Iza, I1)

For Krsna, different ways could also be a particular method that have been commonly used in other disciplines, is being assimilated and accommodated into another area to solve a problem. The solutions maybe simple or complex, but other than what is taught, to tackle a single issue.

"…thinking widely and considering various aspects in their views"

(Krsna, I1)

(ii) Support for failure

Krsna has hinted about providing support for each failure faced by students as an essential aspect of fostering divergent thinking among students. For example, Krsna said that she shall not penalise the students who come up with less sensible answers, but will allow him to continue elaborating as she usher his thoughts back to the concept being taught.

"I will not punish him for that less sensible answer, rather I will advise him to continue elaborating…."

(Krsna, I1)

4.3.3 Theme 3 - Originality

Originality refers to the ability to create fresh, unique, unusual, new, or completely different ideas. In terms of Originality, the teachers' conceptions led to two categories that were (i) Generation of new and innovative ideas and (ii) Own experiences.

(i) Categories - Generate new and innovative idea

Fiza perceived that divergent students would be the one who is able to put forward ideas and creations that are unusual and extraordinary as well as creating something exclusively new beyond expectation.

"Their way of thinking is uncommon (luar biasa)"
"…sometimes what they say is not what we had thought about"
"Even if they are given simple instruction, their output will be bombastic!"

(Fiza, I1)

Krsna also had the conceptions that divergent thinking involves new ideas that are different from others, but she did not look out for an exceptional or bombastic one. To her, the idea may appear to be a simple method of doing something, but it is something that others may have not think about yet

"……..students can come up with new idea to solve a problem…"

"…means ideas that are innovative, new, different from others, thinking differently, …divergently…"

(Krsna, I1)

Iza takes the same stand as Krsna where she too does not expect the ideas to be extravagant, as long as the student has got something uncommon to say or dares to try his own unique way of completing a given task, that indicates divergent thinking.

"……..students ability to produce something uncommon or different from others…that is creativity"
"…….student has his own way of doing things…"
"…during discussion, has uncommon point, or idea from other students"

(Iza, I1)

(ii) Category - Own experiences

"….ideas gained from prior knowledge, combination of ideas from different sources, such as internet or TV shows and real life experiences"
"different students have different idea because what they know or seen is not the same right…?"

(Krsna, I1)

Krsna feels that own experiences holds high quality of originality, because experience varies from one person to another. Different people have different purview pertaining a same problem, because everyone's prior knowledge and real life experiences will imply different understanding of the matter.

However, none of the teachers' mentioned that how divergent thinking students may interpret terms or diagrams which is one of the expects of originality as different students may have different interpretation of any given stimulus.

4.3.4 Theme 4 – Elaboration

Elaboration is the ability of expanding ideas through increased details to develop a basic idea to be a more complex one. Providing opportunity to (i) present projects or assignments, (ii) probing students deeper to elicit and communicate ideas effectively and (iii) ensure mastery of basic knowledge and skills are three underlying categories that fosters elaboration component of divergent thinking among students. The conceptions of these teachers with regards to divergent thinking shows that they had missed out the requirement of mastering basic knowledge and skills as a perquisite to divergent thinking while focusing on other aspects such as students' examination grades. However, the other two categories were addressed by them.

(i) Categories - Present projects or assignments and communicate ideas

Ability to communicate ideas is observed while presenting projects or assignments. Communicate ideas means knowing the facts, presenting series of thoughts in a logical sequence, being a good listener and ready to receive and respond to feedback. It is an art of getting people to buy into your ideas, and it is a skill that has to be polished regularly.

Fiza seems to be more focused on how extraordinary is the product produced by the students. She had the conceptions that students must present their work to classmates to receive feedback from them and see who did the best.

"When given a project to do, the student able to produce something extra than the instruction given and then share it with their friends to get comments from them"
"I would say a students is creative or divergent based on what they can produce in their group work…their production is better than others. The model they produced outperformed the others"

(Fiza, I1)

On the other hand, Krsna and Iza conceive divergent thinking as a process of thinking, aiming at students' thoughts and ideas explained.

"they are usually talkative, but it is not an empty talk…they have sensible thoughts to explain their work"

(Krsna, I1)

"in group work, this student will normally contribute ideas and be cooperative"
"if his friend gives a point, he can add on that idea, or say it is correct or wrong, and come up with other suggestion"

(Iza, I1)

(ii) Probing deeper (to propel explanation)

To help the students to have deeper understanding Krsna tries to grasp her students' scattered points and continuously question them, until they could connect those points to elaborate completely.

"….I will advise him to continue…. I mean…I will find some way to question (probe) him…to help him…to explain in a better…creative way.."

(Krsna, I1)

Iza has similar conception too, but her style is a bit different as she sees competitive arguments among her students' leads to deeper explanation and clarification of thoughts.

"when I ask him for his view, he can evaluate his friend's answer by explaining and tries to defend his answer"

(Iza, I1)

4.4 RQ2: Teachers' practices of divergent thinking

In terms of teachers' practices, teachers did not seem to practice effective divergent thinking strategies in their classroom. Teachers' practises were audiotaped and observed in science classroom based on a guide. The practices of the three teachers were categorised base on same themes and categories as in RQ 1.

4.4.1 Theme 1 – Fluency

Categories under this theme, the ability to generate (i) many ideas and (ii) quick responses are being encouraged and well-practised by Fiza, Krsna and Iza. These teachers have used different approaches to encourage students to give many, quick ideas as what could be observed based on the guide.

(i) Categories - Many Ideas

In Krsna's class, she had a brainstorming session with students, asking them to give examples where the concept of balancing and stability is required or observed from different aspects. She gave random categories such as sports/ games, buildings, animals, shapes, structures and positions. Students were actively responding by saying out their answers aloud and as quick as possible as they casually tried to compete among friends.

T : name the sports where balancing is crucial…
SS :gymnastic….cycling….ballet…GrandPrix…(overlapping answers)
T : ok…now show me how does a gymnast tries to balance his body?
SS: like this teacher…see…(a student randomly demonstrated the act of opening the hand wide and adjusting his feet as though he is trying to balance on a narrow pole, while another student tries to swiftly spin his body by pivoting on his toe)

(Krsna, O1)

The class was full of laughter and fun as the students came up with many examples, acts and gestures. The teacher asked an open ended question and allowed the students to pour in their ideas. At the same time, she did not evaluate the students' answers immediately whether it is right or wrong, but

just kept demanding for more examples from various aspects to flow in. At the end of the session she collectively praised the whole class for being responsive.

T : next, how can we classify different types of shapes?
SS : regular and irregular shapes (whole class)
T : well, give me more examples of objects in….regular shape
SS: whiteboard, rulers, Tupperware (overlapping answers)
T : ok…then what about irregular ones?
SS: leaves, foot prints, watermark on my paper (shows it)
T: wow…you guys can come up with so many examples! Good, now lets move on..

(Krsna, O1)

Upon receiving many ideas from students, Krsna would continue her lesson from there to further explain the concepts.

Another example by teacher Fiza was when she indirectly tried to help the students narrow down answer related to the concept being taught (lower centre of gravity for better stability) without giving evaluative remark on the previous answer

T : when you board a speedboat, what you will be asked to do?
S : to wear safety jacket (answer too general)
T : safety jacket, ok.., other than that? What if you are still standing?
S : to be seated

(Fiza, O1)

From here, Fiza immediately explained to the whole class why we have to be seated in a speedboat in terms of stability.

(ii) Category - Quick Response

While asking for examples, Krsna allows the students to share experiences related to stability with actions or gestures such as riding a bike, taking photographs, movements of animals and human; and structures of buildings and vehicles. Students in her class could respond quickly with

confidence without taking time to think because they have seen or experienced it by themselves.

> *T: show us how do you ride a bike on a winding road?*
> *S: like this (he demonstrates how he would manoeuver the bike)*
> (Krsna, O1)

Krsna continued probing the student why is it important to manoeuvre the bike in such a way and related it to the concept of stability.

4.4.2 Theme 2 – Flexibility

Different direction or uses, and support for failure are two sub-themes that counts for flexibility. Krsna provided vast room for flexibility in classroom, especially for different direction and uses compare to Fiza and Iza who focused on support for failure.

(i) Category - Different direction or uses

Krsna diverted her students to discuss concept of stability from different aspects such as stability in animal, plants, sports, buildings, vehicles and daily activities. She also appreciated students' outcome that is different from being taught

T : How can we determine centre of gravity of a regular shaped object?
S : by folding it equally
T : that's good, but what if the object cannot be folded? Such as a piece of wood…
S : maybe we can try to balance it, by trying to hold it at different points until it doesn't fall
T : Yes, you can use that technique too!
(Krsna, O2)

She accepts the other method tried by the student to determine centre of gravity. In another case, Krsna praised the student who used mathematics logic to determine centre of gravity of a 100 centimetre ruler by dividing it equally

> *S: the middle point of a 1 metre ruler is the 50cm mark at the scale.*
> *T: Yes, correct…it is good that you can think from that angle*
> (Krsna, O2)

(ii) Support for failure

Failure is an opportunity for students to receive feedback on their strengths as well as their areas of improvement for the purpose of getting better. When reframed as a good, constructive, and essential part of learning, failure is a master teacher. In the context of this study, failure means, "you can do better, we believe in you, here is some feedback: revise, and try again!" These scenario were observed in classroom.

Fiza has given each group five pieces of A4 papers, cellophane tape and scissor to construct a structure that must be tall and stable. They were allowed to do anything with the papers given to fulfil the task. Once they are done with it, the representative of each group explain to the rest of the class how did they manage to build the structure, and why is it done in such a way. Then, there is this one group which their structure appears to be less stable. While explaining, the students realised the problem with their structure is because of its height.

> *T : The structure of your building is less stable, because the centre of gravity is high. So Aisyah, if you are given a chance, how can you rectify it to be more stable?"*
> *S : I can try to reduce its height, but then my structure will be the shortest of all. Maybe I can do something to the base to make it stand properly..*

T : ok…now try it and show us again before the class ends

(Fiza, O2)

Fiza has given a chance for the student to stabilize her structure. Iza also potrayed support for failure, by reminding students to keep trying. Demanding students to keep trying and to think of other ways is also one way of supporting failure without telling them directly that that something is not right and has to be rectified.

T : try again,…… try to think of other ways..

(Iza, O1)

4.4.3 Theme 3 - Originality

Generation of new and innovative ideas, being able to express own interpretation of terms or diagram and sharing real life experiences are three categories that contributes to the Originality component of divergent thinking.

(i) Category - Generate new and innovative idea

In Krsna's class, students were told to imagine the design a new shampoo bottle that would be convenient to be held and used, without being rigid pertaining the designing of the bottle.

T : Base on your knowledge on stability, how will you design a bottle for a shampoo company? What aspects will you consider while designing?
S1: the bottle has to be slim and light, easy to hold.
S2: It has to be tall but stable, to fill in more shampoo.
S3: Bottle must be made of plastic, so that it wouldn't break off easily.
S4: a cone shape bottle, teacher! Stable and unique right…hihi (giggles)

(Krsna, O2)

Based on the students' responses, Krsna asked the students to draw their design on a paper, and then point out the stability factors that had been

considered while designing. This resulted to the emergence of many own, unique designs that were uncommon in market that looked stable.

(Krsna, FN2)

(ii) Category - Interpretation of terms or stimulus

Fiza and Iza did ask their students during the first lesson itself, "what is stability"? The students gave various answers, but finally, they told the students to refer to the exact definition given in textbook and said that is the correct answer while the other answers were all somehow inaccurate. On the other hand, Krsna did not ask for any definition of terms in her first lesson on the chapter. At the beginning of second lesson, she asked the students "pertaining the previous lesson, what do you understand about stability?"

S1 : being able to stand in position strongly
S2 : if the object is stable, it will not fall easily, can stand longer
S3 : stable also means balance, because when we are balance we are Stable

(Krsna, O2)

Krsna took in all those answers and said all of it are acceptable ways of defining stability and continued lesson for the day. She did not ask the students to refer to textbook definition because she felt the students answers were true statements explaining the concept of stability so there is no need to stick onto the words in textbook.

"Normally I don't encourage my students to read out the definition from the book, no point….because they won't even remember it. Better to let them define in their own words, can tell us what they truly understand, and if the idea is there then it is correct"

(Krsna, FN2, IC2)

(iii) Category - Own experiences

While discussing the concept of stability in class, teacher demanded the students to share their own experiences and thoughts, either seen on TV or they have done in daily life. A few active students stood up to envisage and describe their moments as follows.

S1: body position as a photographer (legs slightly bent forward)
S2: riding a motorbike on a curvy road (body tilted to one side)
S3: structure of building (Pyramids in Egypt has very wide base)
S1: body position as a weight lifter and then a boxer (legs apart, coordinated with movements of arm)
SS: explaining shape of rhinoceros, pangolins, giraffe, crocodile in relation to its stability

(Krsna, O1)

This process took about 10 - 15 minutes, and the students were excited to share more of their experiences. Krsna told her students to think and relate their experience to the factors that affects stability.

4.4.4 Theme 4 - Elaboration

Providing opportunity to (i) present projects, (ii) probing students deeper to elicit and communicate ideas effectively and (iii) to ensure mastery of basic knowledge and skills are three underlying categories that fosters elaboration component of divergent thinking among students.

(i) Category - Present projects and communicate ideas

All three teachers allowed students to present their work (stable paper – made structure and wooden structure) to the rest of the class. While presenting, student receive feedback from their classmates and teacher.

(FN1, Fiza, Iza; FN2, Krsna)

(ii) Category - Probing deeper

Krsna followed up the suggestion given by her students to help her further elaborate. Krsna asked her students about stability in sports, and one of the students mentioned about a gymnast walking on a narrow pole. The teacher probed the student for elaborate further with facts.

S : gymnast spreads open both hands while trying to balance on narrow poles
T : why?
S : to increase stability
T : yes, but you need to explain a bit more…on how the stability is increased? What is being done by spreading the hands? Which factor comes in here?

(Krsna, O1)

In another scenario, Krsna asked students give examples of stability in animals. As the student responded, Krsna continuously asked short questions that kept the student elaborating his idea until he could relate it back to the concept learned.

S : rhinoceros..
T : how is the shape of it?
S : short, fat..(giggles).. heavy..
T : so how does it support its body?
S: its leg can support
T : describe the legs of rhinoceros..
S: Its big, short, feet is wide
T : ok now, relate that to the factors affecting stability…connect all together…
S : rhinoceros is a short animal…. with wide feet…hhmm means the centre of gravity is low but base is big, so it makes rhinoceros a stable animal even though it is fat..

(Krsna, O2)

Krsna had successfully probed her student to help them express their ideas clearly.

(iii) Category - Basic knowledge and skills

All three teachers well emphasized factors that affects stability and techniques to determine centre of gravity by asking student to repetitively state the factors affecting stability and constantly reminds the students to relate the concept while elaborating examples.

Besides that, one of them drilled students to answer questions in book to gain mastery.

(Iza, FN2)

4.4.5 Summary

Fiza

Fiza has 10 years of teaching experience. While observing her practises, the researcher noticed the questioned asked is mainly close-ended, and often there was a limitation for number of responses. For example, the teacher asks for only two factors that affects stability, instead of allowing students to give more ideas that they may think of. When she was asked why the limitation was given, she said because only that two is in their syllabus. Moreover, she stated that it was because of time constraint.

"*based on the syllabus requirement, only two factors are listed, so I focus on that first*"
"….if I wait for too many ideas,then…it will take a lot of time..and..we are also rushing for time to finish the syllabus, so better to move on fast"

(Fiza, IC1)

Fluency component of divergent thinking is not strongly fostered in classroom. Besides that, this teacher tended to inhibit flexibility and originality among her students because most of the time, students were not allowed to wonder about other possibilities or new ideas. For instance, teacher did not wait for students to share their own interpretation of terms learned in this chapter, such as "*stability*", "*centre point*", and "*centre of gravity*" but straight away directed the students to read out aloud the

definition from the textbook. When the researcher asked why she did so, she said it was because definition is something that had to be accurate, and cannot be self-defined or simply given another meaning. Therefore students had to know the exact definition of terms as stated in the textbook.

> *"because…in science, definition has to be exactly correct, students cannot give own sentence as it won't be accepted in exams. Better they follow proper textbook definition"*
>
> (Fiza, IC1)

While relating examples to the concept of stability, the teacher explained and elaborated all the examples. Thus the teacher provided these examples and even some of the examples were unknown to students.

> *Teacher showed many examples via PowerPoint presentation*
>
> (Fiza, FN1, FN2)

During the period where students were told to prepare a stable model using the materials given, all the groups produced a structure which was almost similar to one another and with less variations. This could be because, the teacher had previously showed pictures of some models as examples and hoped that the students would get some idea of what was required to be done. Students explained their work and teacher gave remark at the end. Basic knowledge and skills were emphasized as required by the curriculum specification while limited divergent thinking fostering practises were portrayed.

Krsna

Krsna has 27 years of teaching experience. In overall, this teacher demonstrates that she is able to foster divergent thinking in science class. She kept her questions open-ended and gave way for her students to come up with many answers (fluency) from various aspects (flexibility). She listened attentively to every answers, and took

it into consideration what would be discussed later. The students seemed to be very comfortable in sharing their views without holding up or withdrawing their answers.

While discussing on application of this concept, students came up with their own, unique examples (originality), where the teacher accepted each one of it and then guided the students to explain more extensively (elaboration). Those examples brought up by the students were part of their own life experiences where they got the chance to share it with classmates.

Besides that, the teacher continuously supported and encouraged her students to try out their own ideas during activity, and then shared it with the whole class. By the end of the lesson, the teacher has successfully emphasize the learning of basic knowledge and skills while fostering almost every component of divergent thinking.

Iza

Iza is clearly a very exam oriented teacher. Throughout her lesson, she kept emphasizing on exam questions and answers that would be helpful for students to score high marks. She fostered certain level of fluency by asking open-ended questions, such as encouraging students to give their view on the pictures shown and did not immediately give evaluative remarks. However, she restricted the number of points that she accepts from each groups due to time constraint. As the lesson progressed, Iza slowly began to dominate the lesson.

Divergent thinking aspects of flexibility and originality lacked tremendously. This was observed when the teacher discussed a list of her examples from various books related to stability by giving lengthy explanation about it instead of asking the students to elaborate (FN1, FN2). When the asked the teacher why she prefers discussing her examples instead of expecting it to come from the students, she stated

that students must be familiar with examples that were common in exam questions, so that they would be able to answer in exams. At the same time, some students may come up with very different examples that they themselves did not know how to relate or explain and they might risk losing marks because, at the end of the year, the exam marks is what going to reflect their achievement.

> "*students must be aware of common examples in exam questions to help them to write the correct answer and explanation. Sometimes, when students give their own example, which is not discussed before, they will not know how to explain, so they will give one word answer and loose many marks in exams*"
>
> (Iza, IC1)

Besides that, she also focused on only two main factors influencing stability because it was in the curricular specification. Furthermore, the teacher gave written exercise to intensively drill students to be able to answer exam questions (Iza, FN1, FN2)

During the activity part, students produced structures similar to the ones teacher previously had shown that were built by other students. Students did not attempt to try out different ideas as they could be doubtful it would be accepted or not by their teacher. Based on the structures produced, teacher asked students to share with classmates the concept of stability that lied within the structure by closely monitoring how they relate it to the two factors that were stressed earlier. Iza has tried to implement the elaboration component in her class, but her practices were limited. As whole, Iza had unintentionally suppress the emergence of divergent thinking ability among her students.

4.5 RQ3: Gaps between teachers' conceptions and practices of Divergent thinking

Generally, Fiza, Krsna and Iza had only acquired informal knowledge of divergent thinking from various sources, where they had conveniently claimed divergent thinking as 'thinking out of the box for many ideas'. This notion could be counted for only one fourth of the actual definition. Teachers are unaware of the four components of divergent thinking, which all of them inevitably measured the level of divergent thinking in a person. Although that is the case, there were few notable differences in conception and practises among those teachers. In certain areas, disparity exist between what has been said and what was being done. For instance, teachers might had the conception, but they failed to foster it in the classroom, and vice versa. Such scenarios would be highlighted to identify the gaps between teachers' conception and practices of divergent thinking. In addition, if those teachers were lacking both conception and practise, that would also be classified as gaps in the context of this research.

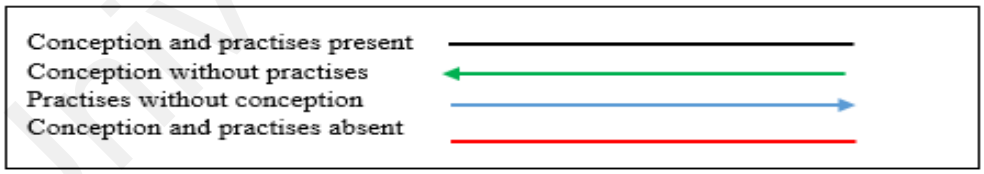

Figure 4.1 Types of Gaps between Teachers Conceptions and Practices

Each coloured lines in Figure 4.1 have different meanings. The black line means, teachers has the conception and practices of the mentioned categories, whereas red line means both were absent from the teacher. Green line means, the teacher has the conception but is not seen in her practice. On the other hand, if the teacher practices without having the conception, it is indicated by the blue line.

4.5.1 Fiza

(i) Fluency

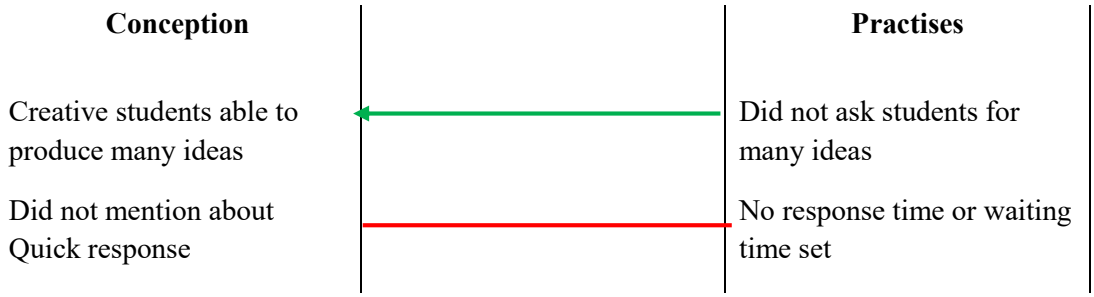

Figure 4.2 Fiza's Gaps for Fluency

Fiza had the conception that divergent thinking is about generating many ideas, however, when it came to classroom discourse, she forgot to impart it.

For instance, Fiza had tried to put forward a number of questions for students to answer, but almost all the time, those questions seemed to be close ended, where students had limited options (two) to evaluate, or required the students to answer yes or no; can or cannot.

> *Scenario 1*
> *Fiza : which bottle is more stable? A or B?*
> *S : A*
> *Fiza : bottle A is more stable, ok Mukhriz, then which one is less stable?)*
> *S : B…*
>
> (Fiza, O1)

> *Scenario 2*
> *Fiza : between a giraffe and crocodile, which animal is more stable?*
> *S : Crocodile…*
> *Fiza : yes…and giraffe is unstable due to its height…right?*
> *SS : yes….*
>
> (Fiza, O1)

This showed that although she knew many ideas from students indicates their divergent thinking ability, yet she was unsuccessful in triggering it. Another part of

fluency aspect is anticipated by how quick the responses were given by students, in other words, fluency is the ability to give many ideas or responses instantaneously. This aspect seemed to be completely absent from teacher Fiza, and the cause leading to this shall be discussed later.

(ii) Flexibility

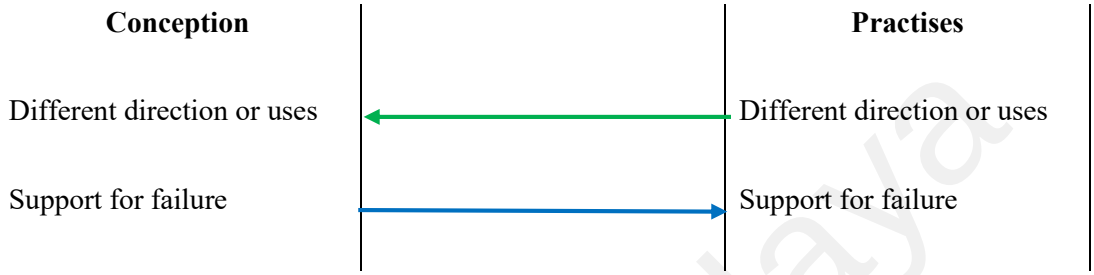

Figure 4.3 Fiza's Gaps for Flexibility

Fiza did not provide the opportunity for students to think from different direction or think of different uses during lesson even though she had the conception. None of the task given were mentally challenging, nor requires the students to think of other ways of doing it. For example, Fiza taught her students a method of determining centre of gravity of regular objects (graph paper cut into shapes of regular polygons) by folding it equally. All the students effortlessly did what they were taught.

Here, in this activity, the students were not triggered to think of other methods to determine centre of gravity, let say, what if the objects were not foldable (made of wood or glass)? What are other simple ways to determine it? At least, once the activity is over, the teacher could have just thrown the questions for students to think of other feasible methods, and that is how divergent thinking could be fostered in classroom; which did not happen.

However, in her practises, she had shown support for students who meet failure regardless of the conception which she did not have, which maybe an innate value of her. She gave a chance for one of the student to rectify the unstable structure to be a more stable one.

(iii) Originality

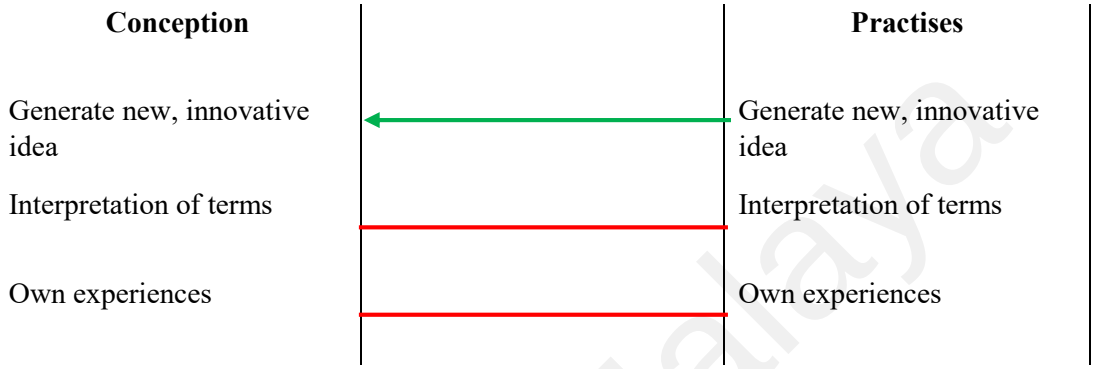

Figure 4.4 Fiza's Gaps for Originality

The need for interpretation of terms and sharing of own experiences as measures to foster divergent thinking were seemed to be absent from Fiza's conception and practises.

> *T: what is stability?*
> *S1: being stable*
> *S2: does not fall*
> *T: hhmm…not really. That sort of answer will not be accepted in exams you know… Okay, now search in your text book for the correct definition.*
>
> (Fiza, O1)

Above conversation was of Fiza's with her students. Although interpretation of terms was not regarded during the interview, Fiza did ask her students what the word stability means to them. Sadly, she failed to follow up the interpretation and suggested the students to straight away refer textbook for the exact definition. During classroom discourse, she was seen delivering lengthy explanation on each examples

from the textbook, instead of asking the students for theirs. Most of the examples shared were not native to the students, and they were just listening to the teacher.

There were also no effort to trigger emergence of new (original) or innovative ideas despite having the conception that divergent students are able to come up with "bombastic output". Even the structures that the students produced, had almost similar build up because teacher had shown them few structures that were stable ones for them to use as a reference. Therefore, the students' structures did not vary much from the teacher's example.

(iv) Elaboration

Figure 4.5 Fiza's Gaps for Elaboration

Fiza conceived that divergent student should be able to produce something better than others when a task is given. They were expected to outperform the rest of them by producing an extraordinary product. She provided opportunity for the students to work on a hands on activity and then students presented their work. While explaining, students also responded to classmates' comments.

However, Fiza did not probe the students for further explanation during lesson. Throughout the lesson, when the students said something, let say when the students replied to her question, Fiza immediately continued expanding the answer with long explanation instead of probing for it to come from the student itself. That was why in

overall, it seemed to look like the teacher talked the most, and dominated the lesson. By the end of the lesson, Fiza was able to emphasize the basic concepts and skills in this chapter through repetition and drilling method by answering questions from the book.

4.5.2 Krsna

(i) Originality

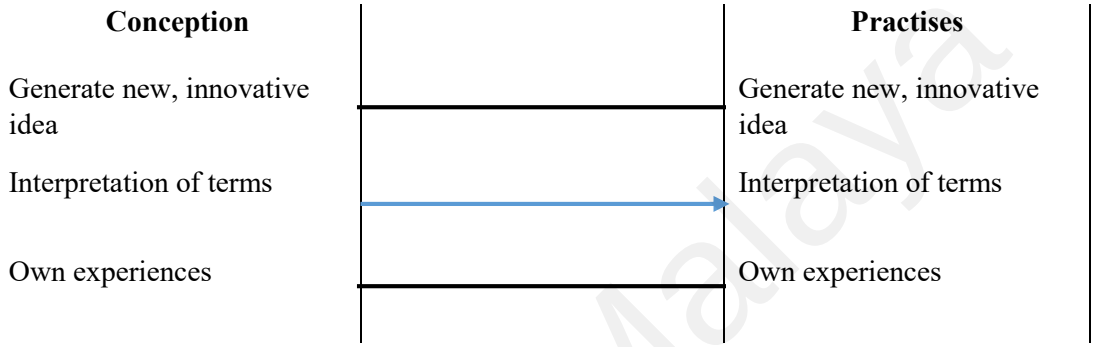

Figure 4.6 Krsna's Gaps for Originality

(ii) Elaboration

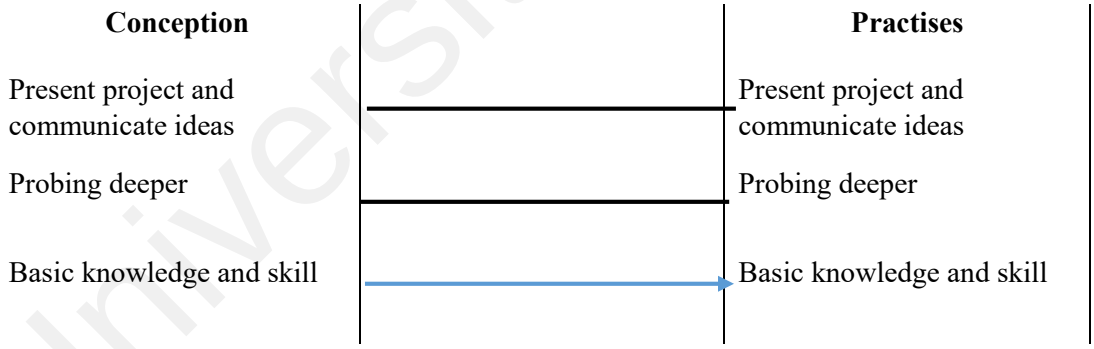

Figure 4.7 Krsna's Gaps for Elaboration

When Krsna's conception and practises were compared for gaps, there are only two gaps found, which she had shown practises although she did not had the conception. Those two were interpretation of terms (originality) and emphasizing basic concept and skills (elaboration). It were not mentioned during the interview but in classroom, Krsna had asked the students to interpret stability and by end of the lesson

she made her students master the basic concept and skills in this chapter. There were no gaps between Krsna's conceptions and practices under themes Fluency and Flexibility as both were inline. In overall Krsna has shown good practises that may foster divergent thinking among students.

4.5.3 Iza

(i) Fluency

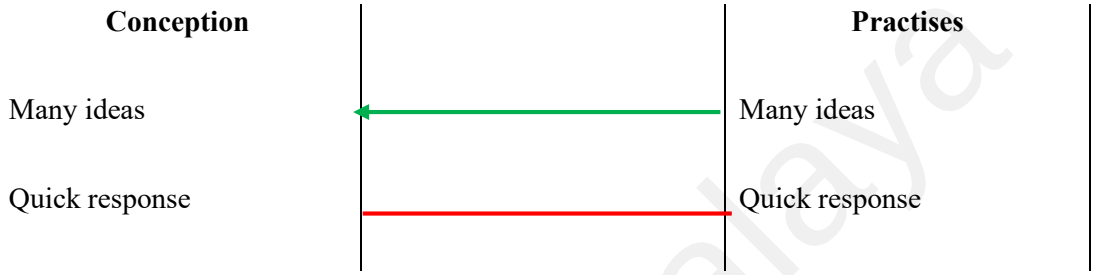

Figure 4.8 Iza's Gaps for Fluency

Iza mentioned about ability to give many ideas as a major part divergent thinking, yet, they failed to set off students to do so at some point. For example, while Iza asked students to respond to the picture shown, restriction has been placed on the number of responses required.

> *"look at this diagram (F1 Car), each group give me two points about this car, only two yeah…"*
>
> (Iza, O1)

In each groups there were five students, even if each students were to give one point, there would be five points all in. But restricting the response to only two, has forced the students to pick on just two points among the rest, where the students whom their points were neglected would feel unappreciated, and such prolonged situation may lead to suppression of ideas in them. Iza could do some changes by improving their questioning method. Extending open ended questions and accepting larger number of responses based on students' knowledge may generate many ideas in a

quick manner to foster fluency. In terms of quick to respond, Iza had neither conception nor practices.

(ii) Flexibility

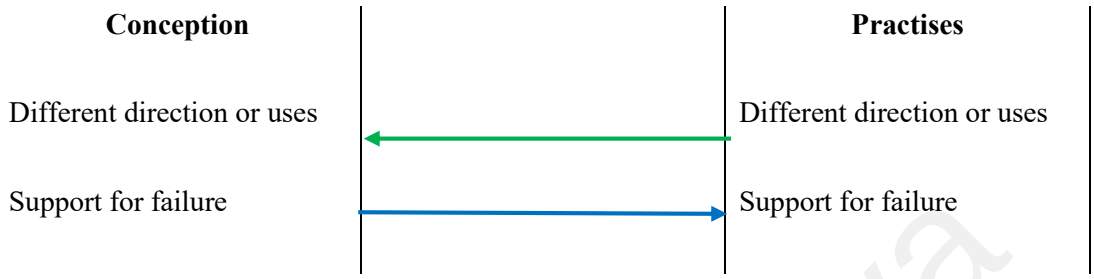

Figure 4.9 Iza's Gaps for Flexibility

Iza had the conception that divergent students would always look for another way of doing a task, however, in classroom, she did not provide opportunity for students to think from different direction or think of different uses. The task given were not mentally challenging, nor requires the students to think of other ways of doing it. Compare to Krsna and Fiza, Iza did not assign the students to try hands-on method of determining centre of gravity. Instead, she just explained verbally how it can be done.

Despite not having the conception on providing support for students who meet failure in their attempt to answer, Iza could still manage to do it in her class by constantly asking them to keep trying instead of saying it is wrong.

(iii) Originality

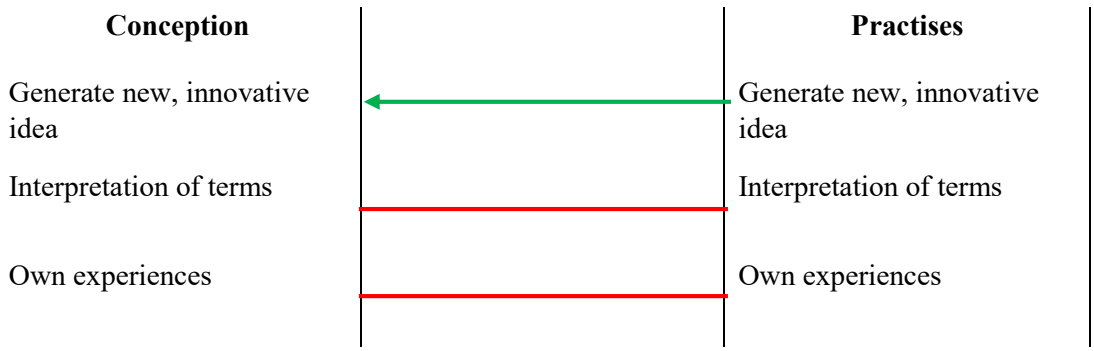

Figure 4.10 Iza's Gaps for Originality

Iza agreed to the notion, production of new and innovative ideas emerges from divergent thinking. Unfortunately, she did not give space for those new (original), innovative ideas to emerge. Moreover, she did not permit the students a chance to share their anecdote related to the concept learned, and this in line with the conception which she did not had.

Iza, has put in some extra effort to gather all the common examples from past year PT3 and PMR examinations, and presented it to the students in the form of PowerPoint slides (FN2, FN3). While shedding some light on the long list of unfamiliar examples, she did not forget to emphasize on answering techniques. However, both interventions do not foster divergent thinking, because there is no effort to trigger emergence of new (original) or innovative ideas. Furthermore, interpretation of terms which was not her conception was not reflected in her practice either, and she referred to terms directly from the textbook for students to follow.

(iv) Elaboration

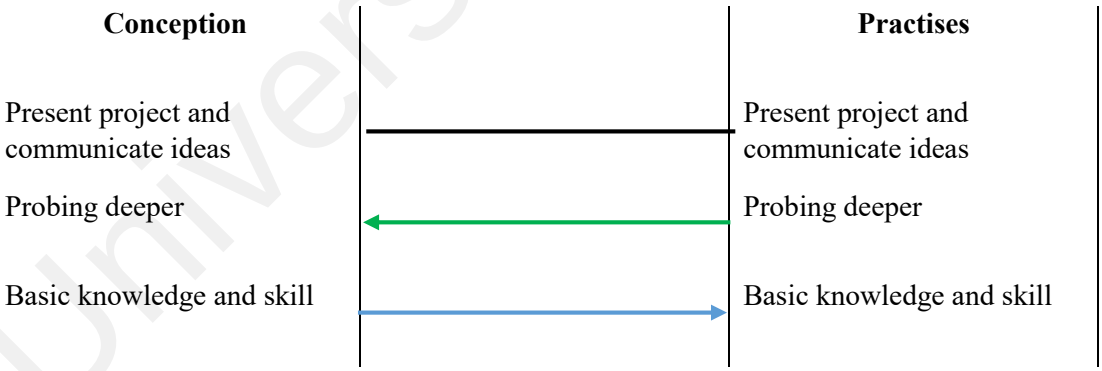

Figure 4.11 Iza's Gaps for Elaboration

Iza deliberately displayed notable amount of practise to foster elaboration component of divergent thinking. She stressed on the factors affecting stability by drilling the students to answer questions and repeating those facts numerous times. She provided opportunity for students to present their built structure. However, despite knowing the students must be probed to gain deeper explanation, she did not do that

in class. She prefers explaining each examples or situations all out because she feels students' answers were often incomplete, therefore they must be guided to explain.

> *"students answer will abit here and there* [incomplete], *so I have to teach them how to write complete answer, if not….hhmm…."*
>
> (Iza, IC2)

4.5 Summary

Considering the fact that teachers' conception of divergent thinking is shallow, their ability to foster divergent thinking among students and to identify existing divergent thinkers in their class could be hindered. This has reflected on teachers' practices in science classroom where it had contribute two scenarios, first, the teacher unintentionally suppressed divergent thinking ability; second, they had unknowingly foster it.

While analysing the gaps that exist between conception and practices, there are more scenarios of teachers not doing what they claim they do compare to what they do by coincident. The implications of this disposition on our students, and education system as whole

CHAPTER 5

DISCUSSION

5.1 Introduction

Creativity comprises of two parts, divergent thinking and convergent thinking. These two criteria are equally important in generating and assessing multiple, novel solutions and finally to make decisions upon existing problem. In many studies, divergent thinking components have been used as an indicator of creativity as whole. For example, Isaksen, Dorval, & Treffinger, (2000) and Lev-Zamir & Leikin, (2011) had adopt fluency, flexibility, originality, and elaboration as the main components of creativity in their research. However, Baer (1993) argues that divergent thinking test scores only indicates divergent thinking ability, which are fluency, flexibility, originality and elaboration. Therefore, this study also adopted those four components to investigate science teacher's conception and practises of divergent thinking.

Divergent thinking, involves producing *multiple* answers (fluency) through processes like *shifting perspective* on existing information or *transforming* it, for instance, through unexpected combinations of elements usually not regarded as belonging together (flexibility). The answers arrived via process of divergent thinking may never have existed before (originality). Sometimes this is merely in the experience of the particular person or the particular setting (Cropley, 2015). Elaboration is the ability to develop the generated ideas further to creatively solve a problem. Therefore, fostering students to think divergently in science classroom builds on student's curiosity, encourages experimentation, perseverance through failure, fosters understanding of difference and appreciate various perspectives and self-expression of ideas.

However, the responsibility of fostering divergent thinking in classroom falls back on teacher's shoulder. It is obvious that the teachers certainly play a key role in the development of creativity due to the fact that they are the main mediators between the curriculum and classroom practices (Aktaş, 2016). Therefore, teacher's conception of divergent thinking which is a major indicator of creativity, and how they are practising it lies as the main interest of this study. The first research question looks into science teachers' conception of divergent thinking. Second research question investigates teachers' practices of fostering divergent thinking in classroom. Thirdly, the emerging gaps between teacher's conception and practises were identified. Those findings will be discussed in this chapter.

5.2 Teacher's Conception on Divergent Thinking

The three teachers involved in this study admit their knowledge on divergent thinking is vague. According to Sriraman, (2005), most of the extant definitions of divergent thinking and creativity given by teachers were vague and complicated due to the complex nature of creativity itself. Their conception is based on assumption and information which are acquired through informal means. Furthermore, given the fact that teacher training programs do not include divergent thinking as a characteristic to be considered when planning and implementing instruction, or even as a general topic (Morgan, Latham & Shifflet, 2009), it is not surprising that teachers do not have enough information or expertise to foster divergent thinking in students. Adding to that, Newton & Newton, (2009 & 2010) found that student teachers' conceptions of creativity and divergent thinking can be inadequate in several ways. Due to this, currently in service teachers may unknowingly discard significant opportunities to foster it in science classroom in schools.

There are strong evidence from six studies (Bolden et al., 2010, Bore, 2006, Cremin, 2006, Crow, 2008, Hong et al., 2009, Newton and Newton, 2009) to suggest that teachers hold a range of preconceptions about divergent thinking and pedagogy which need to be unpicked as part of the professional learning process. Many of these findings emerge from initial teacher education researches. For example, Bolden, Harries, & Newton, (2010) found that teacher conceptions of creativity were narrowed towards convergent thinking but not divergent thinking, and associated with their own unique actions. Their conceptions are predominantly associated with the use of resources and technology, and bound up with the idea of 'teaching creatively' rather than 'teaching for creativity'. These studies are supported by another recent study, which also found high school teachers' conceptions of divergent thinking were narrow and the factors inhibiting it were however, attributed to characteristics of the education system itself rather than those of the teachers (Aktaş, 2016).

Therefore, there could be various underlying factors that contributes to teachers' conception of divergent thinking that are needed to be unfold. Since divergent thinking can either be fostered or suppressed in the classroom, maybe, it is important to understand the factors which affect teachers' conceptions of students' creativity in terms of divergent thinking in future studies (Rubenstein, McCoach & Siegle, 2013).

5.2.1 Common Conceptions on Divergent thinking among teachers

While analysing conceptions of the teachers in this study, there are three conceptions that were found to be similar among all of them. The common conception among those teachers pertaining divergent thinking are students having (i) many ideas, (ii) thinking out of the box, and (iii) producing uncommon or extraordinary outcomes. Having many idea counts for Fluency aspect of divergent thinking. Thinking out of

the box is perceived as Flexibility, and uncommon or extraordinary outcomes is regarded for Originality. The other conceptions identified were absent in some while present in others. The common conceptions identified in this study is consistent with the findings of few others which will be discussed hereafter.

5.2.1.1 Many Ideas

Ability to generate many ideas could appear to be a common conception to all those teachers because the use of Fluency aspect in the assessment of divergent thinking has become popular since about ten years ago (Batey et.al, 2009). Fiza, Krsna and Iza have been exposed to the teaching field during that era, either being a pre-service or in-service teacher, which could be the reason why they have this common conception on generating many ideas as criteria for divergent thinking or creativity as whole. They could have heard or accidently come across this term since then, which has formed the conception.

According to Aktaş, (2016) and Bryant (2014), teachers in their study also had the conception that creative students are the ones who generates multiple solutions to one problem which counts for Fluency, which is a divergent thinking component. One of the teachers in Aktas's study noted that a creative student is a student who when solving problems produces multiple solutions, while another teacher said something similar, that creative student is a student who tries to produce multiple ways of solving a problem. In addition to that, teachers from the study done by Leikin et al. (2013) are in agreement with the findings of this study too. They have the conception that creative students are the ones who has the ability to solve problems in multiple ways because they can think of many ideas.

Therefore, ability to produce many ideas seem to be a common criteria that is expected from creative or more precisely divergent thinking students by teachers

although they don't know the existence of the word Fluency as a component of divergent thinking. In none of the studies, the researchers have reported that their participating teachers did mention exactly the four components of divergent thinking. So far, they are able to just portray scatters of criteria related to those components.

5.2.1.2 Thinking out of the box

The second most common conception regarded by teachers when they hear the word creativity or divergent thinking is, thinking out of the box, which literally means to see things from multiple angles (Flexibility). Similar finding has been reported by Aish (2014) too. According to Karakale (2000), teachers must emphasize different perspectives and alternatives to promote creativity. Although all of them have said that but their conception of what does it really means remains doubtful. Two of the teachers (Iza and Fiza) were quite unclear and struggles to define what does "thinking out of the box" means in classroom context. To their knowledge, thinking out of the box means to think differently from others, and not to think from different aspects or perspectives as how it is supposed to mean. This finding articulates the result of Atkas (2016) that few teachers in that study also did not mention about generating various solutions for a problem via different aspects, but they kept stressing on the point "thinking differently" from everyone.

However, Krsna seem to have the right conception as she said "considering various aspects" in the process of generating multiple ideas. "Aspects" is synonym to direction, angles and perspectives, as an indicator of Flexibilty. This finding is supported by Atkas (2016) as one of his teachers also had similar conception on flexibility. One of the teachers stated that a divergent student has the ability to "*make use of knowledge from different learning field*" rather than the field which the problem belongs to, to find the solution. This is seen in Krsna's class, when her students

determined centre of gravity of a ruler by dividing its total length into half (applying mathematical logic).

This is firther supported by Lev-Zamir and Leikin (2010, 2013) which revealed that teachers in their studies described students who approaches a problem from different angles as those who have the Flexibility component of divergent thinking.

5.2.1.3 Uncommon, Different or Extraordinary Outcomes

Although there is a vast discrepancy between each of the definitions of creativity and divergent thinking among teachers and theorist around the world, the main elements in all of them include the concept of creating something new or original that is designed for a purpose (Al-Nouh et al., 2014; Aish, 2014; Turner, 2013; Bronson & Merryman, 2010; de Souza Fleith, 2000). These findings were also parallel to other older researchers' findings (Cropley, 1999; Feits, 1998; Fryes & Collings, 1991) that teachers mostly focused on originality of something while defining divergent thinking (Yilmaz, 2011).

Teachers in this study seem to have mutual conception too, that the output by divergent thinking students will be normally extraordinary, uncommon, novel or original. Furthermore, this findings also articulates the results of Bryant (2014) that creative students undergoes divergent thinking process that results in a product that brings something unequivocally new, and has value.

However, it is believed that many teachers see the term creativity or divergent thinking and associate it with being artistic rather than the intended definition of original and purposeful ideas (Tapinos, 2016, Aish, 2014). This means, teachers expect students to produce a product (a thing) or design that can be seen, touched or used.

In a survey on teachers by Cachia & Ferrari, (2010) found that 79% of respondents agreeing or strongly agreeing that creativity in terms of divergent thinking is the ability

to produce something original. Similarly, the teachers in this study also have the same conception on this. For instance, Fiza stressed that "*output of divergent students will be bombastic*", while Iza claimed creativity is "*student's ability to produce something uncommon*", although they did mention earlier in the interview that creativity and divergent thinking involves thinking out of the box. Contrarily, Krsna's stand on Originality reflects on thought processes solely. To her, new idea can be also a feasible method of doing something, but it is something different that others may have not think about yet, and it does not have to be extraordinary.

Although teachers in this study have common conceptions that refers to Fluency, Flexibility and Originality, the degree of conception differs from one another. This is because the conceptions were assumptions made by each of them based on their expertise (Morgan, Latham & Shifflet, 2009) and teaching experiences (Long, 2014), considering the fact that they were not exposed to divergent thinking or creativity through formal education. Furthermore, the term itself remains as an elusive and imprecisely defined concept among teachers and researchers (Hondzel, 2013).

5.2.2 Conceptions that differ among teachers

5.2.2.1 Quick to respond (Fluency)

Other conceptions held by teachers are found to be present in one or two of them, while absent from the others. For instance, under the theme Fluency, only one teacher (Krsna) mentioned that divergent students will be able to respond in a quick manner. This conception can be accepted because, most of the divergent thinking test gives importance to time limit. For example, the most widely used tests, Torrence's Test of Creative Thinking, (1974) and Alternative Uses Test designed by Guilford, (1967) for participant to generate lots of ideas, is a time-constraint test. Participants were expected to generate as many ideas as possible within the given time frame,

normally in 20 to 30 seconds. Then the generated responses were evaluated and scored based on four components of divergent thinking (fluency, flexibility and originality) to determine one's creativity level.

5.2.2.2 Support for failure (Flexibilty)

Under the theme Flexibility, only Krsna has the conception that students has to be given proper support in the form of motivation and encouragement to continuously foster students to be divergent.

> *"I will not punish him for that less sensible answer, rather I will advise him to continue elaborating…."*
>
> - Krsna

Krsna said, when her students gives answers that deviates too far away from the topic or when their suggested solution does not work out the way it should be, she would request them to continue explaining themselves, modify ideas or consider other aspects until they could try connect it back to obtain a solution. That will make the students feel that their ideas had been appreciated, and not being neglected for being inaccurate. In future, the student will have the motivation to try giving his ideas again.

This finding is supported by Ozden (2005). According to Özden (2005), to foster creativity, espeacially the divergent thinking aspect of it, a teacher is expected to responds to unusual questions from students, values learners' ideas while listening to them and helps students learn to cope with failure and frustration by accepting it as part of the process. This approach will keep the student as an independent learner whom looks forward to improve. These criteria are scored for flexibility in Ozden, (2005)'s research.

5.2.2.3 Present projects or assignments and communicate ideas (Elaboration)

Unlike Fiza, for Elaboration theme, Krsna and Iza agrees that divergent thinking students will explain their work and be able to communicate ideas effectively. They conceive that these students will be prepared to present their work, share opinions, receive feedbacks and respond to it, debates to justify ideas and improve their work. This finding is aligned with findings in the study by Gralewski, (2019), that teachers' belief divergent students always have personal opinion and they would defend their own opinion and try to convince others to accept his or her solutions.

5.2.2.4 Probe for deeper explanation (Elaboration)

To expand elaboration, Krsna and Iza conceives that teachers must probe students deeper to propel explanation wherever needed because they might have more things to say in their mind. Sometimes, while presenting, students may not go in detail, assuming others will understand, but actually such assumption may leave others in the lurch, and unconvinced.

Therefore, when students were presenting their work, sharing experiences, or giving examples, teachers must look out for opportunities to get the students involved in in-depth explanation if the students' responses are too shallow or unconvincing. Literature states that divergent thinking students are full of ideas (Chan & Chan, 1999; Hoff & Carlsson, 2011) and they are imaginative (Aish, 2014; Aljughaiman & Mowrer-Reynolds, 2005). Hence, teachers should try to probe students deeper and guide them to express their imagination and ideas in the right path.

5.3 Teachers practices

All three teachers had put in some effort to foster divergent thinking in classroom, despite being unclear of the conception. The degree of those practises differs among three of them. Generally, student-centred approaches such as, group work, dialogues, and guided enquiry are approaches that are insufficiently applied and adopted by science teachers in this study. Teacher-centred approaches which includes giving lectures and using ICT for teachers' presentations, were obviously apparent in Fiza and Iza's classroom. As a result, the teachers' activities became the foundation of teaching and learning processes, while the students become quiet listeners and passive receptionists. This is a common phenomenon observed in Alsahou, (2015)'s study too.

5.3.1 Fluency

5.3.1.1 Many ideas

The practises under Fluency that fosters divergent thinking are asking students for many ideas and nurturing students to be quick to respond. Among three teachers, only Krsna is seen to be eliciting students to come up with many ideas. Krsna triggers many ideas from students via open ended questions. She normally gives a category, and let the students to suggest as many related ideas that they can think of to be discussed further.

One good thing about asking open-ended questions is, it have many possible answers that are not pre-determined, therefore, open-ended questions help students develop divergent thinking. According to Kampylis & Berki, (2014), to encourages the active involvement of students and facilitate divergent thinking, teachers may focus on the actual experiences and thoughts of the students when questioning, rather than on what they have read or experienced second hand. This is obvious in Krsna's class,

where most of the discussed ideas or scenarios are of the students' real life experiences rather than what is pictured in the textbook.

Fiza and Iza constantly prefers close ended questions in their class, which is aimed to test comprehension and to aid retention of information of the topic learnt. Futhermore, instead of asking for many ideas from students, they are the one listing out examples, which are mostly second hand experience or unfamiliar ones. This practise of them is not surprising because, past researchers found that on average, approximately 60% of the questions asked in classrooms are closed-ended and 20% are procedural, which is to simple recall facts and methodologies (Cotton, 1989; Fries-Gaither, 2008; Kampylis & Berki, 2014).

These findings are similar to current study, where two out of three teachers (approximately 67%) were prone to ask close ended questions rather that open ended ones.

5.3.1.2 Quick to respond

However, none of the teachers explicitly fixed a time frame for students to encourage quick response from students. Based on observations, Krsna, allowed more respond time for students, compare to Fiza and Iza who seems to restrict number of responses. Krsna believes that, although creative students are quick to respond, but when more time is given, they can think and come up with more ideas, which may be useful, as long as it doesn't take up the whole lesson. This is supported by Van Mondfrans et.al (1971) that increased time to respond would increase fluency. Moreover, Kampylis & Berki (2014) suggested that increased wait-time for answers as much as possible, may create a positive climate to encourage responses. On the other hand, Zabelina & Ganis (2018), firmly stood that divergent thinking ability of an

individual is strongly associated with higher cognitive control process, which literally means shorter thinking time to respond, similar to Guilford, (1967) & Torrance (1970).

5.3.2 Flexibility

The enhancement of flexibility, a top indicator of creative achievements denoting a person's divergent thinking (Konstantinidou & Zisi, 2017), were almost absent during observations.

5.3.2.1 Think from different direction

Teachers' practices to foster divergent thinking that could be observed were, to allow students to think from different direction and to provide support when students meet failure. According to Konstantinidou & Zisi, (2017) the top most unseen teachers practise in their study was encouraging students to think in different directions under the flexibility domain. This is similar to the finding of this study. Among three teachers, only Krsna allowed her students to think from different direction. Students in her class looks into concept of stability from various aspects, such as stability in animals and human, buildings, vehicles and sports activities. Furthermore, her students were also allowed to try different techniques that can be used to determine centre of gravity.

This finding is in line with Cropley (1997)'s suggestion to encourage flexible thinking to foster creativity by offering opportunities for the students to deal with different situations. Flexibility it is one of the component of divergent thinking and is also one of the most popular qualities connected with creativity as whole. According to Thurston and Runco (1999), it is an important aspect of the creative cognitive process, as in the divergent thinking model (fluency, flexibility, originality), that allows the individual to see all parts of a problem and supports open-mindedness.

5.3.2.2 Support student's failure

Cropley (1997) and Alsahou (2015) simultaneously proposed that teachers must help students to cope with frustration. In this study, such practice is seen scantily in Fiza's and Iza's, classroom discourse. For example, Fiza gives a chance for her student to rectify her model to avoid the feel of failure.

However, practicing this category alone doesn't make the students flexible in thinking, because there are minimal variation among the models of other groups and the prototype displayed by teacher. Iza on the other hand would try to encourage her students to keep trying, or come up with other answers if the students' first respond were not accurate. However, Iza tends to encourage students to keep trying, only until she hears what she wants to hear. Iza's motive is to make the students say the predetermined answer that she expects from the students. In this scenario, students collectively feel that they have successfully said the correct answer, but the bitter truth is, they have been forced to conform to what the teacher wants the students to know. This opposes the ultimate importance of positive management of failure, which is actually to eliminate students' emotional barriers and remove inhibitors of creativity.

5.3.3 Originality

Generation of new and innovative ideas, being able to express own interpretation of terms or diagram and sharing real life experiences are three aspects that contributes to the originality component of divergent thinking. However, only one of the teacher, Krsna, did practice a little of all aspects in her class. Fiza and Iza appear to be not practising these aspect of divergent thinking, or practiced poorly throughout observation during their lesson.

5.3.3.1 Students allowed to share own experiences

Krsna spent sufficient time in class to allow her students to share their real life experiences which can be incorporated into lesson of the day, which were not observed in Fiza and Iza's class. Krsna did not list down examples, but she asked her students to share their own experiences related to stability, let it be what they have observed, or do in daily life. Those examples by students were discussed to help the students to see the connections between the scenario and the factors affecting stability. This practice of Krsna's aligns with suggestion by Kampylis & Berki, (2014) that teachers may focus on the actual experiences and thoughts of the students to promote divergent thinking. Moreover, it enables the students to construct new knowledge based on prior knowledge which will be stored in students' long term memory rather than storing it temporarily in working memory by memorising facts blindly.

Fiza and Iza, on the other hand, have presented a list of examples and scenarios from the textbook and reference books which are common in exams to be shared with students. Unfortunately, most of it were unfamiliar to students, yet they listened to teachers' explanation as it could be important for exams. Therefore they become passive learners in class. Runco, (2004) stressed that expecting students to think about topics or examples chosen by teacher which are irrelevant to their own experience would contribute to a slump in divergent thinking and it does not support constructivism where much importance should be placed on students' prior knowledge that could be extended to construct new knowledge.

5.3.3.2 Generating new and innovative ideas

When it comes to generating new and innovative ideas, Fiza and Iza did not provide opportunities for their students to think of that. Nolan (2012) states that, in order to generate new ideas, one must possess the ability of flexible thinking. In this

case, when students were not trained to think from multiple directions (flexibility) pertaining an issue, their tendency to generate new and innovative ideas will deteriorate as well.

However, Krsna did try to foster students' to generate new and innovative ideas, by focusing on the students thought process rather that expecting students to produce or build something extraordinary immediately. Her students came up with a number of own ideas and explained the feasibility of their ideas towards the needs. Krsna's students could do this because they were encouraged to think from different directions, and they may put forward ideas by considering multiple aspects. Mednick (1962)'s associative theory further supports this finding. The theory describes that an individual moves from idea to idea. One idea leads to another, because they are somehow associated in our memory scheme. It may be acoustically similar to one another that could be connected via function or experiential proximity. The generation of new ideas is, then, a matter of associations, with ideas chained together, one after another. That is why, incorporating students' prior knowledge and real life experiences into classroom lessons would most likely facilitate generation of new, innovative and meaningful ideas.

5.3.3.3 Interpretation of terms

Students' interpretation of terms reflects their conception or understanding of the subject matter. It depicts, how the terms are being associated in an individuals' mental scheme. Some might regard the ability to retain its position as stability, while others could say stable means it does not fall easily. Both interpretations are acceptable, because it is based on an individual's past experience. Krsna asked her students to define terms only during the second lesson, unlike Fiza and Iza who asked at the beginning of the first lesson itself.

What differs between three of them is how they reflect upon responses received from respective students. Krsna accepted her students' interpretations as all those were reflections of what they have learnt in the first lesson. Fiza and Iza on the other hand, did ask their students to interpret terms and diagrams, but, they could not agree with those interpretations as they expected textbook definition from the students. Finally, students were told to follow textbook definition closely. This is one way of teacher forcing students to conform to what teacher wants the students to understand and accept as truth (Aljughaiman, 2005).

5.3.4 Elaboration

5.3.4.1 Present projects or assignments

All the teacher did provide opportunity for students to present their model that were built and share their strength and weakness of what they produced to a certain level that differs among teachers. This finding aligns to findings of Konstantinidou and KIzi, (2017) where the effort to enhance communication and collaboration were frequently observed in classroom. Students were provided opportunities to exchange ideas and views to foster elaboration aspect of divergent thinking and promote teamwork as well. Besides that, teachers who provide students opportunities for group activities focus on encouraging cooperation, which are crucial in 21st century learning.

5.3.4.2 Probing deeper for explanation

Krsna has consistently tried to probe explanation from her students. When her students suggest an idea, she helps the student to expand his idea by asking, how, why and what until the student completely explains his idea. According to Konstantinidou and Zisi, (2017), one of the most frequently observed teacher practise to foster divergent thinking was to follow up on students' suggestions with questions to make them think further. The questions does not have to be a long one, but

questioning them “why do you think so?, what will happen by doing that?, how are you going to prove it? Will keep the student’s mind engaged to associate one idea to another, eventually expanding it until it becomes a meaningful, new knowledge.

When teachers use this technique, they do not to give ready solutions and answers to their students. This enhance students’ independent thoughts and searching for solutions and answers based on their own problem identification and finding. These thinking skills put students at the core of the learning process and they thus become more responsible for the learning outcome (Konstantinidou, Zisi, & Michalopoulou, 2014).

On the other hand, Fiza and Iza did not probe the students to give further explanation because, they both are so used to readily explaining for the students. They could be doing it unknowingly because to them, they feel they are helping the students to see the connection and obtain new information. The students just have to say a one word answer, and the teacher immediately continues it to lengthy explanation. With such inappropriate teaching methods and styles for fostering creativity, students become passive listeners, and this is considered to be the most common barriers to creativity in education (Kampylis et al., 2009).

5.4 The Gaps between Teachers Conceptions and Practices

The gaps observed in this study were similar to findings of some past researches. The underlying factors that could have widen the gaps between conception and practice are lack of knowledge on divergent thinking among teachers, teaching experience, curriculum, assessment and examination which relates back to Theories-of -Actions.

5.4.1 Lack of knowledge on divergent thinking

Teachers take great ownership in what and how they teach, which sometimes creates a narrowing view in what they want students to create (Aljughaiman & Mowrer-Reynolds, 2005). If teachers go in with an idea of what they want their students to achieve, and use that vision to assess what the student has created, then they are limiting the creativity that is happening within the classroom (Tapinos, 2016). On the other hand, Al-Nouh et al., (2014) found that, when it comes to creativity, teachers are unsure of the definition, doubtful of what is involved or afraid to take risks with the curriculum as it could lead to judgment by peers and authoritative figures, which hinders teachers from fostering creativity in classroom. What can be concluded by these studies is, without having the knowledge of creativity and divergent thinking precisely, teachers are unable to foster it effectively in classroom (Konstantinidou, Zisi, and Michalopoulou, 2014; Kampylis, 2009).

Teachers in this study that were not exposed to teaching for creativity could not effectively deliver in class. Most countries, including Malaysia, either do not include creative thinking skill subjects in teacher training courses or authorities fail to train teachers on how to implement these skills accurately in classroom context (Al-Nouh et al., 2014; Siti Hajar, 2008). This could be one of the reasons teachers lack the knowledge and understanding of creative or divergent thinking.

5.4.2 Teachers' experience (years of teaching)

As teaching experience is also seen as one the factor influencing teachers' ability in fostering divergent thinking, many researches has considered comparing the years of teaching experience towards the parameter researched (Meyer, 2004; Kampylis, 2009; Lee and Seo, 2006; Liu and Lin, 2014; and Long, 2014). Meyer, (2004) did a comparative case studies of novice teachers' and experienced teachers'

conceptions of prior knowledge and how they use this knowledge to make instructional decisions. Findings suggest that novice teachers hold insufficient conceptions of prior knowledge and its role in instruction to effectively implement constructivist teaching practices. On the other hand, expert teachers hold a complex conception of prior knowledge and make use of their students' prior knowledge in significant ways during instruction.

Similar situation is observed in this study as well. Among all three teachers in this study, Krsna has the most experience in teaching, followed by Fiza and Iza. Therefore it explains why Krsna habitually provided more opportunity to her students to share many ideas and examples of their own, exhibits openness to experience and plans her lesson by taking into account the student' prior knowledge. Krsna considers students' prior knowledge and experiences that can be brought into the lesson to be discussed and expand those ideas for better understanding of the concept learned. Being an experienced teacher, who had the benefit of knowing the content and knowing how to teach (Berliner 1994; Smith, 2000), Krsna was able to focus on her students. She has a wider range of meanings for the concept taught and able to work with her students' ideas by flexibly allowing them to shift between science content and life experiences which fosters divergent thinking in students.

Krsna who has 28 years of teaching experience could effortlessly foster divergent thinking via constructivism whereas Fiza and Iza who has far lesser teaching experience, were unable to connect prior knowledge to foster divergent thinking. As for Fiza and Iza, their attention were more focused on the syllabus content they needed to teach and they did run into situations where their ideas about what their students should know and what their students did know did not match. This conflict between

expectation and reality leads to pressuring the student to conform to what the teacher wants them to know (Meyer, 2004).

5.4.3 Curriculum, Assessment and Examination

The idea that schools kill creativity has gained popularity in recent years (Beuke, 2011; Bunday, 2013; Robinson, 2006, 2012). Creativity is not an educational priority in most of the educational models. Empirical studies revealed that original thinking declines in fourth grade probably because children has learned to conform to the structure of formal education and follow certain rules and suggestions set by school more often (Runco & Cayirdag, 2013). Dobbins (2009) found that creativity is restricted by curriculum and learning objectives.

Same thought runs in minds of teachers in this study. They claimed the curriculum is loaded and time is limited. It is compulsory to complete the syllabus by year end, and teachers have less authority on deciding the content. Fostering creativity sees to take up a lot of time, for example if students were involved in lengthy discussions in every lesson or projects. This may delay the teachers to move on to next chapters, therefore they tend to restrict students' thinking and interaction in class.
This factor is also supported by Mann, 2005; Neill, 2003; Rashimah, 2012, and Siti Salbiah et.al 2015. The need to finish the syllabus and emphasize given for examination grades have hindered creativity to bloom in science classroom.

Jeffrey (2002) and Tomlinson, Little, Tomlinson, and Bower (2000) criticized overemphasis on measurable improvements on assessment outcomes (exam grades) that come along with too many constraints and structure leading to suppressing creativity and innovation. According to Alsahou, (2015), students' understanding of the textbook information was the priority of all science teachers in his study and teachers were keen to repeat information focusing on the general concepts and core

information in each lesson. This probably due to teachers' stubborn desires to prepare their students for the exams, similar to teachers in this study, Fiza and Iza. They explain thoroughly the concepts and examples while focusing on examination questions. During that period, students were told to listen carefully, not to talk, because these are important points in exams.

The fact that exam grades matters cannot be neglected, as it is the main interest of stakeholders in education, such as parents, ministry, employers and potential investors. Exam grades are the major concern for students to enrol in boarding schools, universities, and to seek job in future (Alsahou, 2015; Bereczki & Kárpáti, 2018). On the other hand, Exams and standardised test are seen as one of the common barrier to foster creativity (Aish, 2014; Al-Nouh et al., 2014; Fairfield, 2010; Hondzel, 2013; Hong & Kang, 2010; Olivant, 2015; Scott, 2015; Shaheen, 2011, Siti Salbiah et.al., 2015).

Hong & Kang, (2010) said that constant pressure placed for student achievement in South Korea hinders fostering of divergent thinking. Students' achievement has been a long time major concern in most of the Asian countries, including Malaysia (Rashimah, 2012; OECD, 2012). Less creativity cultured in science classroom for a long time has reduced students' ability in creative problem solving (Siti Hajar, 2008; OECD, 2012 & 2015).

5.4.4 Gaps in this study: Conception without Practice

5.4.4.1 Many ideas (Fluency)

All three teachers have the conception that divergent students will be able to generate many responses to one given problem. However, only one of them (Krsna) constantly asks students for many ideas, while the other two teachers seems to be rigid in allowing ideas to pour in.

Iza fostered certain level of Fluency by asking open-ended questions, such as encouraging students to give their view on the pictures shown, however, she restricts the number of points that she accepts from each groups due to time constraint. Plus, she also consistently pays more attention to points that are frequently used as answers in examination, stating the importance of accurate answers to obtain marks. On the other hand, Fiza normally put forward close ended questions, such as yes or no, without demanding further explanation, where the students were left with no options to come up with own ideas. Besides that, Fiza tend to follow up students' answers with her own explanation.

To foster students to generate many ideas, open ended questions plays a key role (Konstantinidou, Zisi, and Michalopoulou, 2014). According to Torrance (1981), open-ended questions are considered key elements in nurturing students' creativity and leave room for divergent thinking. However, despite its importance, Fiza and Iza did not use open ended questions effectively to serve its purpose although they had the conception. Kampylis and Berki (2014), based on their research findings, agreed that on average, only about 20% of the questions asked in classrooms are open-ended, which is in line with the findings of this study too. Although teachers realise divergent student are able to produce many ideas, yet they did not provide the opportunity for students as they unknowingly asks close ended questions, list down examples or ideas readily for students to listen or read from the slide.

5.4.4.2 Thinking out of the box (Flexibility)

Although all the teachers did mention about thinking out of the box, yet some of them struggle to internalise its true meaning due to own assumptions. This has reflected on their classroom practises. For instance, Fiza and Iza, hardly gave any

chance for their students to think of the box. In other words, they failed to trigger students to think from different directions or aspects during the lesson. This fact advocates that Flexibility was not cultivated in the observed lessons although flexibility is one of the most popular qualities connected with creativity.

According to Thurston and Runco (1999), flexibility it is an important aspect of the creative cognitive process as in the divergent thinking model that allows the individual to see all parts of a problem.

Research findings by Konstantinidou and Zisi, (2017), reveals that the top most unseen practices in teachers was encouraging students to think in different directions, which directly reflects the case in this study. Therefore, can be concluded here that although teachers are able to say thinking out of the box as a criteria for divergent thinking, yet it goes missing in their classroom practices.

On the other hand, Krsna has tried to impart Flexibility component in classroom parallel to the conception that she has. She allowed students to suggest solutions from different aspects and let them justify it.

5.4.4.3 Uncommon, Different or Extraordinary Ideas (Originality)

Two out of three teachers in this study did not provide the opportunity for the uncommon, different or extraordinary outcomes to mushroom in classroom. The lessons were mostly teacher – centred and less involvement from students in terms of sharing ideas or experiences that maybe different, original and useful. Throughout the lesson, students were not asked to think of any uncommon or unique ideas regarding the topic. Teachers readily delivers various examples that have been accumulated in PowerPoint slides from few books. When the students were told to build a model of a stable structure, those teachers presented a prototype to them, and all the students tried

to closely imitate the structure without much deviation. Here, there are no new, different, extraordinary outcomes that emerged as claimed by the teachers.

Fluency and Originality aspects of divergent thinking are highly related (Dumas & Dunbar, 2014). For new, unique, innovative ideas to flourish, students must be used to generating many ideas (fluency). When these teachers fails to foster fluency, it has directly reflected on their students originality aspects too. Therefore, teachers need deep knowledge of divergent thinking to foster all four aspects of it because neglecting any one of it may reflect on the other aspects as well.

Moreover, instead of asking students to share their own experiences, those teachers asked students whether they have experienced or aware of certain phenomenon. Fiza and Iza discussed situation such as the position of a camel when a trader is loading his goods on it, but those are completely unfamiliar to the students, and beyond their interest to know as well. While ignoring that fact, teacher continues explaining in detail the camel's position, and its importance of doing it for stability, feeling compelled to deliver the knowledge to the students. They did not provide the space for uncommon, different, unique, extraordinary examples to emerge in their class. This shows that teachers lacks the awareness and skill on how to trigger Originality to nurture divergent thinking students despite having the conception that it is one of the important criteria.

5.4.4.4 Probe for deeper explanation (Elaboration)

According to Konstantinidou & Zisi, (2017), one of the most observable teachers' practice was following up on students' suggestions with questions to make them think further, which can be observed strongly in Krsna and scarcely in Iza, but not in Fiza. Krsna and Iza have the conception that teacher is responsible to propel in depth explanation from students, but not Fiza. Opposing the findings of

Konstantinidou & Zisi, (2017), when it comes to practice, Iza does not probe students for in depth explanation, instead, she gave lengthy explanation for each scenario or example regarding the concept of stability.

This could be due to the teacher's belief that probing students acquires a lot of time and completing the syllabus is her main concern (Rashimah, 2012; Siti Salbiah et.al, 2015).

5.4.5 Gaps in this study: Practices without Conception

5.4.5.1 Interpretation of terms (Originality)

Although the teachers did not mention the need to allow students to interpret terms or diagrams shown as stimulus, but still they practised it scarcely in classroom. However, the purpose of asking students for own interpretation has been neglected by Fiza and Iza. These teachers asked for students' interpretation of the word stability, then, being unsatisfied of all the answers they received, they instructed the students to refer to its actual definition in textbook. By stressing the definition stated in textbook is the most accurate one to be followed, divergent thinking has been inhibited. This could be another effect of teacher lacking knowledge on divergent thinking and relevant practices to foster divergent thinking. Depending on the expectations that teachers place on students' response, it may either stimulate or inhibit divergent thinking (Dhingra & Sharma, 2015)

However, Krsna accepted her students' response about stability, as long as it carries the right conception on stability. Students defined with the use of examples, which shows the students' have constructed knowledge in depth. The need to follow textbook definition were not mentioned in her class. Although she did not has the conception of asking students for their own interpretation of words, yet to a certain extent, she managed to practice this aspect quite well.

Research by Silvia, (2008) and Dumas & Dunbar, (2014) found that Fluency and Originality aspects of divergent thinking are highly related. Therefore, this could explain Krsna's ability to foster Originality by asking for students' interpretations just like how she foster Fluency by demanding students to give many ideas.

5.4.5.2 Emphasizing basic knowledge and skills (Elaboration)

Despite not having the conception of the need to emphasise on the mastery of basic knowledge and skills, all three teachers did naturally emphasise on basic knowledge and skills in classroom through repetition of concepts and drilled the students with questions verbally and via written exercises from the workbook. According to Cropley (1997) and Cayirdag (2017), teachers need to ensure their students have mastered factual knowledge of a topic, so that they have a solid base for divergent thinking to take place. Basic Knowledge and skills are perquisite for divergent thinking and teaching content knowledge can foster creativity (Baer and Garrett, 2010). Teachers in this study felt compelled to deliver knowledge readily to students, and that is why the lesson turns out to be more teacher centred.

However, most of the time, teachers mistakenly thinks that, to teach content and academic skills, rote memorization is the only way, while creativity in classroom may be disruptive and better be ignored (Baer and Garrett, 2010). This finding explains why the teachers in this study did not mention anything about mastering basic knowledge in their conception of creativity, because they do not seem to realise the synergistic connection between these two.

The teachers in this study admitted that drilling is the best method to prepare the students for examination, because at the end of the year, that is what matters the most to the school administration, education department, and also parents.

5.4.5.3 Support for Failure (Flexibility)

Fiza and Iza did show support for students in their classroom practices, despite not having the conception. These teachers mutually agreed that they wanted to help to students to rectify their work or responses because they belief that the students willingness and effort to try must not turn out to be a complete waste. Although sometimes, it appears to be like they were trying to make the students conform and fit into teachers' set of ideas, since both of them does not consider responses from various directions. This were obvious when the teachers waited until they hear what they exactly wanted to hear from the student. According to Morgan et.al, (2009), it is possible that teachers who are not well versed in the characteristics of divergent thinking and thus are not able to identify divergent characteristics when it is present in a student, will eventually force a certain degree of conformity on students and suppress their divergent thinking ability.

5.4.6 Theories of Actions

According to the Theories-of-Action, when conceptions (espoused theory) are not parallel as practices (theory in use), problem would arise. The findings of this research is supported by this theory. Teachers who already possess limited conception on divergent thinking (espoused theory) have shown disparity in their practices (theory in use). Besides that, For example, teachers who believe divergent thinking can be fostered by allowing students to come up with many new, original ideas, have unknowingly suppressed emergence of ideas in their class by not providing the right opportunity for students.

5.5 Suggestions

As the need for creativity emerges more in the workforce (IBM, 2010), educators' response to this phenomenon becomes more important. Although most creativity researchers believe that creativity is teachable, learnable, and improvable (McWilliam, 2007; Murdock, 2003; Rhodes, 1961; Torrance, 1970, 1972; Torrance & Torrance, 1973) yet creativity has not often been an educational priority (Geist & Hohn, 2009; Maisuria, 2005). This gap between the need, current practice and conceptions can be closed in several ways such as amendment of educational policies and teacher education programmes that would improve educational climate and teaching styles and methods. Most of such changes, however, would require changing or improving the teaching practices. Therefore, teachers play a central role in any such effort (Esquivel, 1995).

5.5.1 Educate Teachers about Divergent Thinking

One of the ways to educate in-service teachers will be through continues professional development (CPD) programs. Professional development will play a crucial role in preparing in-service teachers to include divergent thinking activities into today's curriculum (Roue, 2011). Fawcett and Hay (2004) encourage collaboration, stating that professional development is the foundation and should be attended by all educators in order to establish effective creativity fostering teaching models and activities. The heart of these professional development models lies in teaching educators to be enablers, who attend to students' creations, their creative development, and the communication of their creative ideas. Since teachers in this study claimed that none of them heard about divergent thinking during their undergraduate studies, it is highly recommended to include divergent thinking and creativity as a course in teacher education program itself.

Furthermore, teacher education programs need to emphasize and engage students in meta-cognitive activities through which they become aware of how to use prior knowledge to help students construct meaningful knowledge and diversify their thought processes (Meyer, 2004). In addition to that, Adzliana Mohd Daud, Jizah Omar, Punia Turiman & Kamisah Osman, (2012) suggested that efforts should be made to relevant prospective science teachers in Malaysia to enhance creativity in order to encourage creativity in the classroom.

5.5.2 Trainee-teacher selection requirement

Renzulli and De Wet (2010) argued that selection of teachers could be more important than training the in service teachers because certain characteristics such as openness to experience, flexibility, non-authoritative personality, optimism and high energy are the "starting material" and these are hard to cultivate with training. Researcher proposes that selection of teachers who are expected to cultivate creativity in their students should have a strong conception of creativity, high efficacy and take personal responsibility to improve their capability to foster students' creativity and divergent thinking. Teachers who innately possesses these qualities may be able to recognise divergent thinking students and encourage such thought process continuously. Besides that, teachers will be able to foster other students to be divergent thinkers too. This would reduce the chances of suppressing divergent thinking abilities among students.

5.6 Implication

The study on teachers' conceptions and practices of divergent thinking has its own implications on students creative ability as divergent thinking is a part of creativity. Teachers who are said to have the conceptions of divergent thinking, and

practices it in their classroom will be able to nurture divergent thinking skills in them. Divergent thinking students will be able to contribute many, new solutions for new problems that constantly emerges in the demanding field of science and technology. Furthermore, this study serves as an eye opener for educators and policy makers on the importance of divergent thinking. Teachers especially, have to be exposed in depth about divergent thinking and curriculum designers shall leave spaces

5.6 Conclusion

In conclusion, inadequate fostering of students' creativity might be due to teachers' insufficient knowledge on divergent thinking, training and insufficient continuous professional development in contemporary issues such as creativity.

Teacher are trapped in a void between demands of a high-stake system and their conceptions of divergent thinking and creativity.

To address this conflict, teachers need rigorous preparation and training to improve their classroom practices. Of course, education and training alone cannot make the difference in teachers' effectiveness on creativity promotion. Creativity, especially divergent thinking should be more valued in education circles. Educational institutions, policy makers, and teachers themselves need to take multifaceted action through policies and initiatives to further foster divergent thinking; otherwise, it will remain hidden to our young world citizens. Therefore, educational policies and teacher education programmes should take steps to bridge the gaps if teachers are to successfully implement divergent thinking in the science classrooms.

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