THE BIOTECHNOLOGY FOR YOUNG LEARNER: EMPOWERING GIFTED CHILDREN TO BRING ACCESS TO SCIENCE KNOWLEDGE IN INCLUSIVE CLASSROOMS IN INDONESIA

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Abstract

This paper presents an approach to inclusive pedagogy that enable gifted children and high performing students to bring science knowledge in inclusive classrooms of peers with diverse needs. Biotechnology for Young Learner is a program developed for gifted and more able students to learn and give tutorials of some specific themes of biotechnology to their diverse peers including children with special needs such as learning difficulties, slow learners and intellectual disabilities. Gifted and high performing children from three inclusive primary schools in Yogyakarta, Indonesia, have been involved in this program for two years. Classroom teachers provide the student tutors with series of trainings before they deliver tutorial sessions for their peers. We drew qualitative data gathered from observations, teachers' interview, teachers' reflections, children's journals, and photos. We examined the impacts on the student tutors behavior, classrooms' knowledge development, students' attitude towards learning science, sharing and contributing skills, and social interactions. It is observed that the program has supported student tutors to develop characteristics of expert learners. We also have identified barriers of maximizing participation and engagement of all children. False conceptualizations of inclusion of classroom teachers were the main barriers presented. The paper concludes by highlighting the need for schools to establish cultures that challenge the way teachers conceptualize difference, differential learning and academic achievement. Teacher should be encouraged to work towards a pedagogy focusing on social justice and equity, viewing classroom as community of learners, enabling classroom members to contribute, rather than individuals with deficits to be fixed.

Keywords: Gifted children, Inclusion, Knowledge access

Background

Following the world's education reform on advocating inclusive education as stated in The Salamanca Statement and Framework for Action on Special Needs Education (UNESCO, 1994), many nations have striven to implement the policy of inclusion into their educational systems including Indonesia. Indonesian government has delivered a policy of inclusion in the National Education System Law 23/2003 (UU Sisdiknas, 2003). Inclusive education according to the legislation is defined as an education system that provides opportunities to all students with SEN and special talents and/or intelligence to have access to education or learning in an educational environment together with other students. In its application, inclusive education aims to provide as many opportunities as possible to students with SEN and develop education that recognizes diversity and non discriminatory towards all students with physical, emotional, mental and social limitations as well as those student with special talents and/or intelligence so they can receive quality education according to their needs and abilities (Aznam, 2012).

Since the regulation was endorsed, more schools are adopting the inclusion practice, which facilitates children with ad without special needs within the mainstream school setting. Children with superior intellectuality or gifted children are also considered as children with special needs who require special approach. Schools may not optimally facilitate children's superior intellectual capacities, which are shown by their broad knowledge and good problem solving skill. As consequences, in class, gifted and higher performer children could experience disengagement because their aspiration and needs are not fully met.

The School Contexts

Sekolah Tumbuh is one of primary schools in Yogyakarta providing inclusive education for their students. The school accepts student with special needs, including student with autism, intellectual disabilities, and physical disabilities as well as student with giftedness, learning together with their regular peers. The school has three campuses with 22 students per class among those are 2-4 students are students with special needs in each class. SD Tumbuh 1: 185 students with 15 students with special needs, SD Tumbuh 2: 138 students with 16 students with special needs, SD Tumbuh 3: 70 students with 9 students with special needs.

The school views the importance of designing special program for gifted students as teachers are aware of the high needs of challenges in academic subjects. Furthermore, in effort to implement principles of inclusion, the school is committed to open the access to science knowledge for all students.

Facilitating Gifted Students

Giftedness has been conceptualized in a number of different ways over time. Sternberg and Davidson (2005) published a second edition of their book *Conceptions of Giftedness*, some 20 years after it was initially published and asked contributors to answer the following questions: "what is giftedness, how does your conception of giftedness compare with other conceptions, how should gifted individuals be identified, how should gifted individuals be instructed in school and elsewhere, and how should the achievement of gifted individuals be assessed?" (Sternberg & Davidson, 2005, p. ix).

Among many definitions, Pfeiffer (2003) advocates schools' adoption of not one, but three separate yet complementary categories of giftedness. A tripartite approach of giftedness views giftedness through three lenses: the lens of high intelligence, the lens of outstanding accomplishments, and the lens of potential to excel. This could offer comprehensive understanding of giftedness. Further, he defines the gifted child as one who "demonstrates a greater likelihood, when compared to other students of the same age, experience, and opportunity, to achieve extraordinary accomplishments in one or more culturally valued domains." (Pfeiffer, p. 16, in press).

Differentiation in curriculum, teaching and learning represents the fundamental strategy when dealing with identified students with additional learning needs. The approach has been defined as 'teaching things differently according to observed differences among learners' (Westwood, 2006). It is important to note that differentiation in the curriculum is one of the foundations of effective teaching. It has assumed significant importance for students with special needs, yet remains applicable across the entire curriculum and at every level of the achievement spectrum. Fundamentally, therefore, it represents recognition that learners are individuals. It is derived from a number of pedagogical approaches, notably those of task analysis, curriculum monitoring and review, pupil grouping, and learning and teaching styles. Differentiation is a relatively upfront term to define; most teachers will agree that, because it relates to an input process output model of teaching, it is not easy to put into practice (Gardner, 2009).

Biotechnology for Young Learner

Etymologically, biotechnology means "the study of tools from living things", combining the Greek words "bio" means living organism or life, "techno" means art, skill, system or tool, and "logos" means speech, study of (Wells cited in Kwon 2012). We can conclude that biotechnology is any technique that uses living things (organism or part of organism such us enzyme, gene) to make or modify products, improve them, or develop them for specific uses.

Biotechnology is not new in human life. It has begun when people found the way to fermented fruits into beverage, preserved milk into cheese and butter, and they baked bread. As Samani et al. (2011) mention, these ancient communities founded the means to produce beverages, bread, wine, yeast, soy sauce and tempe (cured bean), without realizing that their activities are actuall reffered to biotechnology. In the 20th century, biotechnology has expanded to mollecular base such as genomic, recombinant technique, vaccine, cloning, and diagnostic tests. So, biotechnology means the use of living system and organisms to develop or make products, or any technological application that uses biological systems, living organisms or derivatives there of, to make or modif products or processes for specific use (UN Convention on Biological Diversity).

Further, biotechnology has been a part of human history for thousands of years and perceived as an indicator of prosperity and development (Kwon, 2012). This subject has improved the quality of our daily lives such as food, health, fuel, and environment. The growing impact of biotechnology globally and nationally over the past few decades has promoted the need for elevating general biotechnology literacy levels in all populations (Kwon, 2012).

Indonesian people recognized local biotechnology, such as fermentation, for long time. Tempe, tape, yogurt, kefir, salty eggs, pickled vegetables are local cuisine as biotechnology product. Modern biotechnology is central to human innovation and our future. Public knew about genetic modified organism (GMO), but they didnot have enough scientific knowledge to understand it. There is a tension about the GMO. As biotechnology develops to molecular genetics, began a large gap between scientists with general public. Communities with limited understanding about biotechnology and science have to deal with conflict between commercial and politic.

Sari (2013) reported a BTYL project for children with visual and hearing impairmant program to encourage children with special needs to produce fermented food, introduce applied science, and increase students; enterpreneurship. In the end of the project, five students who are deaf blind were able to made tempe by themselves.

Biotechnology for Young Learner is a program developed to introduce biotechnology to children especially for gifted and high performing children to give tutorials on some specific themes of biotechnology to their peers including those with special needs such as learning difficulties and slow learners. The program presents an approach to inclusive pedagogy that enable gifted children to bring science knowledge into inclusive classrooms of peers with diverse needs. The project has been running for more than two years. It was originally developed to support behavior issues of some gifted children. The first year program was successful in altering some behavior problems. In the following years, BTYL is focused on the giving access to all students in the schools so that every student has the same basis of accessing science knowledge.

Differentiation of the curriculum for gifted students is the best way to optimize their potential. Usually gifted students have high interesting in science and technology. One of the themes in recent science and technology is biotechnology. Biotechnology is a sample of modern science which provides teachers with a context to show how teams of scientist, technologist, and social scientist work together. It also provides opportunities for students and teachers to explore and critically debate and dilemmas in ethical issues that arise during the process (Phoenix in France, 2007). Furthermore the social and political issues arising from the practice of biotechnology provide a rich context to link science with the life world of the students.

Methodology

Participants

There are participants involved in the BTYL project including: (1) a lecturer in Primary School Teacher Education who has background in Biotechnology. The main roles are to prepare a modul, to train the module to teachers and to prepare teachers as student mentor for student tutors (2) a group of the school teachers who will become mentors for student tutors. The prepared teachers will teach and assist the gifted and high performing students with various themes of biotechnology (3) The gifted and high performing students who will become peer tutors (4) all students and classroom teachers at the schools. The Biotechnology for Young Learner project was implemented at Sekolah Tumbuh with including SD Tumbuh 1, SD Tumbuh 2, and SD Tumbuh 3. This paper focuses on data derived from student. There are 27 student tutors participated in this program. The students' profiles in 2013 and 2014 are shown at table 1.

Table 1 - Student Tutor Profile 2013

No	Initials	Gender	Grade	School
1.	NN	F	5	SD Tumbuh 1
2.	DNY	M	3	SD Tumbuh 1
3.	ARM	F	3	SD Tumbuh 2
4.	FLT	F	4	SD Tumbuh 2
5.	RK	M	3	SD Tumbuh 2
6.	WL	F	Multiage 1,2,3	SD Tumbuh 3
7.	RFF	M	Multiage 1,2,3	SD Tumbuh 3

Table 2 - Student Tutor Profile 2014

	No	Initials	Gender	Grade	Age
SD Tumbuh 1	1.	FSA	M	1	7
	2.	AZSA	F	2	8
	3.	AA	M	3	9
	4.	NHP	F	3	9
	5.	AMM	F	4	10
	6.	ASAP	M	4	9
	7.	APC	M	5	11
	8.	DAW	M	5	11
SD Tumbuh 2	9.	AFS	M	Multiage 1-2	8
	10.	KD	M	Multiage 2-3	9,5
	11.	JE	F	Multiage 2-3	8,5
	12.	AN	M	Multiage 2-3	9,5
	13.	GDF	M	Multiage 2-3	9
	14.	GRM	M	4	11
	15.	WRF	M	5	12
	16.	MADW	M	5	11
	17.	DRS	M	5	11
	18.	SNA	M	5	11,5
SD Tumbuh 3	19.	ABE	F	Middle grade	9
	20.	ATP	F	Middle grade	9
	21.	MRAHY	M	Middle grade	10
	22.	RST	F	Upper grade	8,5
	23.	TBPE	F	Middle grade	9
	24.	LDS	M	Upper grade	11
	25.	ADP	F	Upper grade	11
	26.	LTDW	F	Upper grade	11
	27.	ADF	M	Middle grade	10

Topics and cycle of the project

BTYL covers topics such as (1) Fermentation: yogurt, sweetened fruit, fermented cassava; (2) Agriculture in my country: herbarium, xylem and phloem identification, carbohydrate identification, simple chromatograph, vitamin C identification, composting, water cycle, water conservation, compost tea, terarium, hydrophonic, verticulture, antibiotic test of jamu, swap test; (3) Healing My Precious Earth: measuring air pollution, acid and bases, fat identification, cleaning oil spills, preservatives, antagonistic test, understanding the composting process.

The project has its working cycle starting from preparing modul that is relevant with the National curriculum – teachers workshop – keeping log book and journal – peer tutoring – evaluating and reflecting

Table 3 - BTYL themes 2013

Meeting	Day and Date	Theme
1	10 January 2013	Yogurt and meranti seeds preservation
2	11 January 2013	MIRA: Microscope in a Rush (generic microscope from web cam)
3	25 January 2013	Technique of herbarium
4	08 February 2013	Insectariums
5	22 February 2013	Bio plastic
6	08 March 2013	Fermentation war: microbe that blowballoon
7	05 April 2013	Tape: fermented cassava
8	19 April 2013	Sweeten fruits: diffusion-osmosis
9	03 May 2013	Salty Eggs: the way we preserved foods
10	17 May 2013	The bouncy eggs

Table 4 - BTYL theme and subthemes 2014-2015

No	Item	Explanation
1	Period	October 2014 – May 2015
2	Theme	Healing My Precious Earth
3	Sub theme:	Students learn different types of leaves, roots and plants.
	a. Park, Wood, and Wasteland	
	b. Measuring air pollution	Students measures level of air pollution around the school and identify any particles trapped in the tool used to measure pollution.
	c. Acid and Bases	Students identify acid and bases in food ingredients such as vinegar, lemon juice, and baking soda.
	d. Fat Identification	Students identify types of fat in food and categorise full fat and low fat and decide whether is healthy or not healthy for human body.
	e. Cleaning Oil Spills	Students learn about water pollution around the schools, especially those caused by oil spills and how to clean it.
	f. Preservative effect to the microorganism growth	Student learn how to preserve food using slat and vinegar and compare better way to preserve.
	g. Antagonistic test	Students learn that some elements in herbs contains components to kill bacteria (anti bacteria).
	h. Understanding the composting process	Students learn to make fertilizer from composting process using organic rubbish and identify the influence of compost mixture on the time taken of composting process.
4	Teacher	2 teacher mentors/school
5	Meeting	Once a week, 1 hour per meeting
6	Peer tutorial session	One meeting for each group in the end of program

Figure 2 - Student tutors learning about composting

In regard to peer tutorial sessions, the student tutors were given opportunities to select a BTYL sub theme that they would like to teach to their peers. The structure of the tutorial sessions as follows: a) teacher mentor and student tutor introduce themselves and tell the goals of the activity; b) teacher mentor explains about the experiment; c) student tutors demonstrate the experiment; d) teacher mentors divides the students in the class to work in groups; e) student tutor gives the equipment and experiment materials to each group; f) the students work with the student tutor conducting the experiment; g) the teacher mentor makes a documentation; h) teacher mentor opens the class discussion and the student tutor answers the question from the students; i) teacher facilitating the students to conclude the experiment; j) the student tutor and the students clean up the experiment equipment.

Figure 2 - Students working in group during peer tutorial session

Findings and Discussion

The impacts of the BTYL project on the student tutors' and classrooms' knowledge development, attitude towards learning science, sharing and contributing skills, and social interactions are explored. After joining all sessions of BTYL program, it was observed the student tutors have developed positive learning attitude and skills required to learn and conduct science experiments such as growing patience, following the tasks based on the instructions, showing responsibilities in cleaning the experiment tools. The student tutors also reported that they feel happy and excited and hope that they can join this program again next year.

"I feel happy and excited, it is interesting, challenging, and hard to work"
(ADP, 11 years old)

They also reported the favorite sessions. The sessions on fat identification and preservative effect to the microorganism growth are the student tutors' favorite because they can eat the rest of food that they used for experiment.

"It is cool" (WRF, 11 years old).
"*Nice, I can eat chicken*" (DAW, 11 years old)

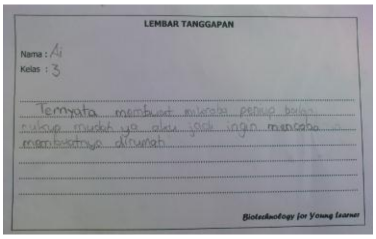
The student tutors also have developed attitude as tutors toward the diverse peers such as showing respect to all children, listening carefully, and being cooperative with any children in their groups. They taught other students proudly and confidently. They showed the experiment step by step so the other students understood what they demonstrated. They learnt science terms in English also gained more knowledge about science and relate the topic to the daily life experience. For example, a student (KD) asked to teacher in *Cleaning Oil Spills* session about how to clean the water pollution in the ocean.

However, the student tutors also viewed peer tutorial session as challenging. One tutor felt frustrated because of chaotic class, while another tutor expressed happiness with the new experience.
"*The children were very crowded in the class*" (DAW, 11 years old)

"*I am happy because I can share my knowledge to my friends"* (ASZA, 8 years old)

In the end of the project, the student tutors were asked to give their reflections.
"*Whoever will be the BTYL tutor next year, I hope they can work hard so they can be scientist*" (DAW, 11 years old)

The other students who joined the peer tutor sessions also show their enthusiastic and active involvement by expressing their opinions. They just needed to be reminded to be careful when using experiment equipment. A student from 2013 session wrote:


LEMBAR TANGGAPAN

Nama : Ai
Kelas : 3

Ternyata membuat mikroba peniup balon cukup mudah ya aku jadi ingin mencoba membuatnya dirumah

Biotechnology for Young Learner

Figure 3 - Student's opinion after peer tutorial session

"It is actually quite easy to make microbe blowing balloon. It makes me want to try it at home." (Ai, year 3)

They expressed that they wanted to join the BTYL project as student tutors next year. One child commented,
"*I want to join the BTYL next year*" (AN, 9 years old).

This is in line with a result with another project of conservation scout program, where more able students were asked to share their knowledge to their classmate. Sari (2014) reported from 70 representative students from Yogyakarta, 53,14 % succeded to managed peer tutoring in their schools. The teachers observed and reported that student tutors in the scout program became more confident, accountable, and enthusiastic to share their knowledge with others friends.

Teacher mentors reported the benefit of this project. They acquired new knowledge about biotechnology that they could implement in their classes and also in daily life. They also can improve their teaching skill with active learning and experiential

learning. They feel happy because they can campaign about scientific attitude to children so they can respect to knowledge and diverse friends. What is more, they understood that inclusive schools actually involving facilitate student with high competency and that this remove their understanding that inclusion is only dealing with children who are less able.

Inclusion, is based on the philosophy that schools should provide for the needs of all children regardless of the ability or disability, and thus ensuring children's full participation (Moore, 1998). Further, More (1998) proposes that acceptance, belonging and community are philosophies in inclusion result in general education classes are structured to meet the needs of all the students in the class. To uphold the principles of inclusion, teachers should be encouraged to work towards a pedagogy focusing on social justice and equity, viewing classroom as community of learners, and enabling all classroom members to contribute.

One way of support for inclusion is the role of peer in children's learning. Utley (2001, as cited in Loreman, Deppeler & Harvey, 2005) reveals that research has consistently demonstrated evidence that enhancing academic performance, improving interpersonal skills and accepting individual difference for a range of student including those with disabilities can be achieved through peer mediated instruction or other collaborative instructional alternatives. Adopting a social constructivism approach that learning is believed as socially constructed, each of the members will benefit of the full participation of everyone.

Conclusion

Children learn through mediation such as materials and social interaction. Therefore, more able peer can act as a model or support for children with additional learning needs to learn new knowledge and skills. The interaction especially affects language and social competence skills. Forms of cooperative learning in inclusive classrooms whether it is done in partner, triad or bigger group among students with diverse educational abilities would benefit all students.

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