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The effect of mother tongue-based multilingual education on the Science achievement and metacognitive learning orientations of Ilocano grade 3 pupils: Implications for policy and practice

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Abstract

The implementation of Mother Tongue-Based Multilingual Education (MTB-MLE) in the Philippines is being criticized by stakeholders whether it is a better approach for pupils in the primary levels than the monolingual-Second language (MSL) approach using Tagalog. Several studies in the past decade attempted to test the effect of MTB-MLE on pupils' learning on different subject areas. However, there is yet no available study on the effect of MTB-MLE on Science learning variables such as metacognitive learning orientations and achievement among Grade 3 learners whose mother tongue is Ilocano. This quasi-experimental study was conducted to test the effect of MTB-MLE on the academic achievement, metacognition, learning processes, and self-efficacy of Ilocano Grade 3 pupils in Science learning. Fifteen (15) Ilocano pupils were randomly selected from each of two elementary schools of a district in Isabela Province, Philippines. The two groups were taught in Science using Tagalog-only (MSL) and Ilocano-Tagalog (MTB-MLE), respectively. Pre and post-assessment were conducted to gauge the pupils' traits in Science. Descriptive statistics, independent-samples t-test, analysis of covariance, and paired samples t-test were used to analyze the data. There was no significant difference between the achievement, metacognition, self-efficacy, and learning processes of the MTB-MLE and the MSL pupils in Science. Moreover, the learning processes of the MSL pupils such as monitoring-evaluating-planning, learning risk awareness, and control of concentration did not significantly improve. Therefore, this study recommends the implementation of MTB-MLE in the primary level, and provides implications for policy and practice for better learning outcomes.

Keywords: Achievement, metacognitive learning, monolingual, MTB-MLE, Philippines, Science

Introduction

There have been steps taken around the world to advocate mother tongue-based multilingual education (MTB-MLE) in the primary levels of education (Burton, 2013). The inclusion of mother tongue in the classroom setting is believed as an important response to the need of upgrading the quality of education. However, the continued implementation and amendment of this approach has brought issues and concerns in the educational arena. The doubts of stakeholders on the capability of MTB-MLE have become an area of criticism and investigation as to whether it is a better approach in teaching subject matters in the primary levels than the monolingual-second language (MSL) approach or not.

Research in the literature attempted to compare MTB-MLE and MSL approach. Various studies conducted abroad claim that MTB-MLE is a better approach. For instance, Awopetu (2016), in a quasi-experimental study on the impact of the use of mother tongue language on children's learning abilities in early childhood classroom in Akure South Local Government Area (LGA), Ondo State, asserts that learners who are exposed to MTB-MLE perform better than their counterparts who communicate mostly in English. This is because they no longer need to mentally translate concepts which are presented in Yoruba language (Mother Tongue) in order to understand them. Awopetu (2016) also affirms that using MTB-MLE as a medium of communication or instruction in a classroom setting strengthens pupils' motivation and makes them feel comfortable and self-assured with the lesson topic. Furthermore, Behrmann (2018), in her quasi-experimental study on the effects of using Kreyol (Mother Tongue) as opposed to French (Foreign/Second language*)* in teaching math and science, confirms a significant difference between the French and Kreyol (Mother Tongue) groups, and in the learners' performance when Kreyol was used as a medium of instruction instead of French. Moreover, Mohamed and Lobo (2019), in their examination of which method *of* teaching between monolingual and bilingual is more efficient and effective in achieving the learning outcomes, and is preferred by the English language learners and gives them better performance results, showed that bilingual/multilingual approach attests to be a more effective and convenient approach in teaching English classes than the monolingual method. Han and Park (2017) also insist that pupils exposed to the bilingual approach are more interactive than those exposed to the monolingual approach.

Some studies in the Philippines also favor the outcomes of MTB-MLE over that of the other approach. Villaruz and Perez (2020), in their study on the effectiveness of MTB-MLE among indigenous learners in Palawan, attest that the Science and Mathematics performance of pupils exposed to mother tongue, Filipino, and English languages are significantly different, but then it is only the mother tongue language that can significantly impact pupils' performance in language subjects. Ricablanca (2014), in his study on the effectiveness of MTB-MLE on pupils' achievement in the field of mathematics in two groups of pupils at San Nicolas Elementary School, also asserts that MTB-MLE learners' achievement is significantly higher than the achievement of learners exposed to English instruction in both posttest and retention test.

Non-comparative studies confirm the positive effects that MTB-MLE has on learners as well. In his study, Lari (2020) highlights that the bilingual method develops the learners' fluency and accuracy in both their first language and the English language and is extremely helpful to learners in gaining necessary skills. Dahm and Angelis (2019) also verify and agree with the former findings and added that mother tongue has a positive effect not only on language learning but also on mathematical learning. In addition, Kioko (2015) has proven that the use of the mother tongue within the classroom can greatly help students' transition from their home to their school as they are better integrated into the learning process hence the conclusion that MTB-MLE boosts the learners' academic achievement and self-confidence which is also supported by Beka, (2016). Arola (2017) stresses also that children who have a solid foundation in their mother tongue, develop better literacy skills and Kioko, Ndung'u, Njoroge, and Mutiga (2014) have provided several success stories about the integration of the mother tongue language in classroom instruction in Africa including educational and economic benefits.

Despite these several studies supporting the effectiveness of the MTB-MLE, a number of other studies refute the idea that MTB-MLE is more effective than the other approach. Gorjian and Sayyadian (2017), for example, posit that monolinguals perform better in reading comprehension than bilinguals. Piper, Zuilkowski, Kwayumba, and Oyanga (2018) too assert that MTB-MLE and non-MTB-MLE have the same benefits on the achievement of English and Kiswahili learning outcomes among pupils in Kenya, but those who are exposed to MTB-MLE attain lower mathematics outcomes. Vela (2015) also argues that the ability of students who are taught using Tagalog (national language) to comprehend Science lessons are better than those students who are taught using Mother tongue, students who are taught using the English language (third language) on the other hand, are the least performing among these three groups. Moreover, Namanya (2017), in a study on the effects of MTB-MLE on the English literacy of children in Silang, Philippines, affirms that children taught in mother tongue showed a decline in English literacy level.

Similarly, several researchers also express the benefits of using the MSL over MTB-MLE. Jago (2019), for example, thoroughly explains that with the monolingual approach lessons can be personalized, students are free to connect with the language they use to the situations beyond classroom setting and share their ideas in their country and even in their society. Espada et al. (2017) agrees to the former statement by asserting that the use of mother tongue language in classroom instruction brings confusion because it makes them re-learn the language they have already acquired naturally, resulting in a dysfunction in interaction and learning.

Adoption of MTB-MLE in the Philippines

For so long, the Philippine educational system adhered to a Bilingual Education Policy with Filipino and English as the only languages used in the classroom settings. But in 2012, this system was amended with the passage and implementation of the K-12 program. The program is comprised of one year in the Kindergarten, six years in elementary education, four years in junior high school, and two years in senior high school. Also among the highlights of this program is the inclusion of MTB-MLE in the primary levels.

MTB-MLE in the Philippines is implemented in two ways: as a subject area and as a medium of instruction. As a subject, it focuses on extending the knowledge and skills of children on the development of their speaking, reading and writing from Grades 1 to 3 using their mother tongue language. As a medium of instruction, mother tongue language is utilized in all subjects from Kindergarten to Grade 3 with Filipino and English being taught as separate foci (Manabat, 2016).

MTB-MLE was implemented to support the goal "every child a reader and a writer by grade one" and to target "proficiency through language" (Rojas, 2016). The implementation of MTB-MLE was institutionalized by the Department of Education through Department Order No. 74, s. 2009. The former Philippine President who signed the Department Order, Benigno Aquino, Jr., even said, "Learn English well and connect to the World. Learn Filipino well and connect to your country. Retain your dialect and connect to your heritage" (Alcudia et al., 2016).

The transition to MTB-MLE in the Philippines is aimed at making education more accessible. According to Genevieve Asenjo, Chair of De La Salle University's Department of Literature, mother tongue-based learning in the country can make education more accessible, especially for those in the margins of society (in Jostol, Mapa & Yu, 2020). The decision to adopt the approach is anchored on the results of the study conducted by Ball (2014) that around 50 to 75 million marginalized children are not enrolled in school because their primary language is not the language of instruction in school.

MTB-MLE on metacognitive learning orientations

Thomas, Anderson, and Nashon (2008) define metacognitive learning orientation in Science as a construct that contains 5 subcomponents namely, constructivist connectivity, monitoring-evaluation-planning, self-efficacy, learning risk awareness, and control of concentration. Constructivist connectivity refers to the learners' construction of connections between information and knowledge across various scientific concepts; monitoring-evaluation-planning might be seen as traditionally related to metacognition that reflects important strategies in learning science concepts; self-efficacy explores learners' perceptions of their orientation to establish and execute actions that are essential to attain science learning goals; learning risks awareness reviews learners' level of awareness to situations that verify unfavorable to their learning; and control of concentration highlights how learners pay attention and exert effort in understanding each lesson discussed in Science class.

There have been claims that MTB-MLE influences the subcomponents of metacognitive learning orientations. According to Tomblin (2019), MTB-MLE develops the critical thinking of a child which in turn leads to satisfying performance and achievement. Busari, Tatira & Madzudzo (2018) support this stating that mother tongue could facilitate students' acquisition of science concepts and therefore, promotes a good Science performance. Ramamoorthy (2020) also agrees asserting that a multilingual child shows higher mental flexibility, processing power, and spontaneity which help in better retrieval of information. Moreover, Tomblin (2019) emphasized that self-esteem is higher for children learning in mother tongue because they feel more comfortable in asking and answering questions, sharing their thoughts, and doing things on their own (Arzadon, 2020). In conclusion, these behaviors foster critical thinking and mean they are more in control of their learning.

Problem statement

The findings in the literature are conflicting and the ideas of stakeholders on MTB-MLE are not consistent (e. g. Abrea et al., 2020 and Ezeokoli & Ugwu, 2019). Despite the continued proliferation and popularity of MTB-MLE in the Philippines, research on this program has been limited. Most of the studies on the effect of MTB- MLE were conducted abroad and in cities, focusing only on the field of mathematics and language subjects using descriptive research designs and look commonly on learners' academic achievement. There is no available study in the literature on the effect of MTB-MLE on Science learning variables such as metacognitive learning orientations and achievement among Grade 3 learners whose mother tongue is Ilocano.

There is a dire need to address the continuous decline of the performance of Filipino students in the field of science (Bete, 2020). The communication approaches used in teaching and learning science may have contributed to the performance and traits of learners. Despite having insufficient evidence supporting the effectivitity of MTB-MLE, *it* is believed to be a good foundation for grade 3 Science learners before going to Grade 4 wherein pure English language is used in instruction. On the other hand, there are also doubts about the successful implementation of MTB-MLE in the Philippines because of various challenges. With the presence of numerous languages spoken in the country, the preparation of learning materials written in these languages could be one of the challenges. Likewise, the teaching and learning of terminologies and concepts in Science subjects using MTB-MLE would not be an easy task.

Considering these observations and data relevant to the implementation of MTB- MLE, it would be of great help to test the effect of MTB-MLE and compare this to the non-MTB-MLE approach in terms of behavioral criteria like Science achievement, metacognition, self-efficacy, and learning processes. This would assess whether the adoption of MTB- MLE in the Philippine basic education is worth it, and could serve as a basis in deciding about educational policies in the teaching of Science in the primary levels.

Objectives of the study

The current study aimed to gauge the effect of MTB-MLE on the pupils' achievement and metacognitive learning orientations in Science. Specifically, the study answers the following questions:

1. Is there a significant difference between the Science achievement and metacognitive learning orientations of the MTB-MLE and the MSL pupils?
2. Is there a significant improvement in the Science achievement and metacognitive learning orientations of the MTB-MLE pupils from pre- to post-assessment?
3. Is there a significant improvement in the Science achievement and metacognitive learning orientations of the MSL pupils from pre- to post-assessment?

Methods

The researcher employed a pretest-posttest quasi-experimental research design to investigate the effect of using mother tongue in teaching science among third grade pupils. The quasi-experiment allowed the manipulation of the independent variable (instructional approach) without randomly assigning the participants to conditions (White & Sabarwal, 2014). The natural grouping of the subjects was maintained instead. Grabbe (2015) pointed out that quasi-experimental design has the advantage in holding higher external validity as it involves real-world interventions. Jaikumar (2018) supported that a quasi-experimental design is more suitable for real world setting and this allow the researcher to evaluate the impact of quasi-independent variables under naturally occurring conditions.

The current study involved two groups of grade 3 pupils from different schools. One section of Ilokano pupils was chosen for each school and fifteen subjects were randomly selected from each section. There was no random assignment done to maintain the natural conditions in both groups (White & Sabarwal, 2014). However, to get rid of selection bias and attribute the difference between the two groups in Science achievement, metacognition, self-efficacy, and learning processes, pre-assessment of the pupils' characteristics on these indicators was conducted. Checking the comparability of their entry characteristics guided the researcher in choosing the appropriate statistical analysis in comparing the groups' existing characteristics.

Participants

The participants were Grade 3 pupils from two elementary schools in the Province of Isabela, Philippines. One class of pupils who use Ilocano as their language at home was chosen from each of the two schools, and then 15 pupils were randomly selected from each class. This number may be considered small for a conventional quantitative research, but experimental research has a different standard in considering sample size. Cohen, Manion, and Morrison (2007: 102) underscore that experimental methodologies would require at least 15 participants while Gall, Borg, and Gall (1996) clarify that there should be at least 15 participants in control and experimental groups for comparison. Moreover, taking a manageable number of subjects would be an advantage in the research setting considering that online learning is a recently adopted learning modality among elementary

schools, especially in the Philippine provinces. Therefore, having a total sample of 30 pupils would make the experiment more controlled, leading to more valid results.

The selected 15 pupils from the first school served as the MTB-MLE group while those from the other school served as the MSL group. The profile of these two groups in terms of sex, age, and who their tutors are, is shown in Table 1.

Table 1. *Respondents of the study*

	Profile	MTB-MLE Group	MSL Group
Sex	Male	5 (33.33%)	6 (40.00%)
	Female	10 (66.67%)	9 (60.00%)
Age	8 y/o	6 (40.00%)	8 (53.33%)
	9 y/o	9 (60.00%)	7 (46.67%)
Tutors	Family Member(s)	13 (86.67%)	14 (93.33%)
	Hired Tutor	2 (13.33%)	1 (6.67%)

As to sex, the MTB-MLE group consists of 5 (33.33%) males and 10 (66.67%) females while the MSL group is composed of 6 (40.00%) males and 9 (60.00%) females. As to age, the MTB-MLE group comprises 6 (40.00%) eight year-old pupils and 9 (60.00%) nine year-old pupils, while the MSL group has 8 (53.33%) eight year-old and 7 (46.67%) nine year-old. As to their tutor(s) at home, the MTB-MLE group identified that 2 (13.33%) have a hired tutor, while there is only one pupil (6.67%) in the MSL group with a hired tutor. The data shows that the two groups are comparable to some extent, in terms of their frequency and percent distribution per profile.

Research instruments

A Science test was adopted from the Department of Education Resources to measure the achievement of the pupils for the Second Quarter in Science 3. The test consists of 40 items identification and enumeration type of examination formulated in Filipino. Items 1 to 6 measure pupils' ability to identify the common animals in the bounty*;* items 7 to 16 require them to identify the body parts of animals and their function (e. g. what parts of the animal's body were used for); items 17-30 ask the pupils to complete a table and identify the relationship of body parts of animals to movement, habitat, food getting; items 31 to 34 measure pupils' ability to compare animal needs to human needs, and to tell how to be safe with animals; and lastly, items 38 to 40 allow the learners to provide three main remedies or practice for insect and animal bites.

The Self-Efficacy, Metacognition, Learning Inventory-Science (SEMLIS) developed by Thomas, Anderson, and Nashon (2008) was adopted to assess the pupils' metacognitive learning orientations in Science. Thomas et al. (2008) reported that the instrument underwent exploratory factor and Rasch analyses and has factorial validity, discriminant validity, acceptable Cronbach reliability, and Rasch reliability. The SEMLIS contains 30 items with five subscales; namely, Constructivist Connectivity (7 items), Monitoring, Evaluation and Planning (9 items), Self-Efficacy (6 items), Learning Risk Assessment (5 items), and Control of Concentrations (3 items). The 30 items were translated into Filipino and Ilokano through context analysis to ensure that the meaning of the statements is retained so that third grade pupils can better comprehend or understand its content.

Data gathering procedures

Pre-assessments were conducted for both MTB-MLE and MSL groups to determine their entry Science traits in terms of achievement, self-efficacy, metacognitive skills, and learning processes in Science. Lesson plans and PowerPoint presentations were prepared which are good for two months and were validated and tailored to the most essential learning competencies (MELC) in Science III Second Quarter. The MTB-MLE group was taught in Science using Ilocano and Tagalog languages while the MSL group received a pure Tagalog instruction. A two-month online learning-teaching through Google meet was conducted. The two groups were taught for three 4-hour sessions in a week in two months. After the intervention, a post-assessment on pupils' Science achievement, self-efficacy, metacognitive skills, and learning processes was conducted by administering the same questionnaires used during the pre-assessment.

Data analysis

Frequency and percent were used to determine the distribution of the pupil-participants in terms of their profile such as sex, age, and who their tutors at home are. Shapiro Wilk tests and Levene's tests were run to check for normality and homogeneity of variances assumptions. The results of these tests were all not significant, attesting that the use of parametric tests for difference was appropriate. The absence of random assignment in quasi-experimental research necessitates the use of statistical controls. Hence, the comparability of the MSL group and the MTB-MLE group in terms of their entry achievement, metacognition, self-efficacy, and learning processes was checked by conducting an independent samples t-test. Considering that the results were not significant (which indicates that their entry characteristics were controlled), another independent samples t-test was conducted to compare the post characteristics of the two groups in terms of achievement, metacognition, self-efficacy, and learning processes in order to determine whether MTB-MLE is significantly different from MSL approach. A one-way analysis of covariance (ANCOVA) was further employed to validate the independent samples t-test by statistically controlling for pre-assessment scores. Finally, a paired samples t-test was used to test whether there was a significant improvement in the achievement, metacognition, self-efficacy, and learning processes of the two groups from pre-assessment to post-assessment.

Ethical considerations

The study observed the ethical dimensions of research. Consents were asked formally from the district supervisor, school heads, and concerned parents for the conduct of the study among the pupils. They were informed about the research purpose, procedure, benefits and risks; and that participating in the study is voluntary. Confidentiality and anonymity *were* observed by not disclosing the names of the schools and the participants in the manuscript.

Results

Table 2 shows that there were no significant differences between the pre-assessment scores of the MSL group and the MTB-MLE group. Statistically speaking, the two groups had the same entry characteristics on achievement ($t = -1.40$; $p > .17$), constructivist connectivity ($t = .978$; $p > .33$), monitoring, evaluation and planning ($t = 1.44$; $p > .16$), self-efficacy ($t = 1.83$; $p > .07$), learning risk assessment ($t = 1.90$; $p > .06$), control of concentration ($t = .637$; $p > .52$), and overall metacognitive learning orientations ($t = 1.89$; $p > .06$).

Table 2. *Pre-assessment scores of the control group and the experimental group*

Variables	Treatment	*n*	*M*	*SD*	*t(28)*	*P*
Achievement	MSL	15	25.93	6.77	-1.40	.172
	MTB-MLE	15	29.33	6.51		
Constructivist Connectivity	MSL	15	20.06	3.78	.978	.337
	MTB-MLE	15	18.60	4.40		
Monitoring, Evaluation & Planning	MSL	15	30.46	7.15	1.44	.161
	MTB-MLE	15	27.40	4.10		
Self-Efficacy	MSL	15	20.13	5.98	1.83	.078
	MTB-MLE	15	16.46	4.94		
Learning Risk Assessment	MSL	15	15.86	4.10	1.90	.067
	MTB-MLE	15	13.13	3.75		
Control of Concentration	MSL	15	10.73	2.34	.637	.529
	MTB-MLE	15	10.20	2.24		
Overall	MSL	15	97.26	19.02	1.89	.069
	MTB-MLE	15	85.80	13.79		

Table 3 shows that the post-assessment scores of the MSL group and the MTB-MLE group in Science achievement ($t = -0.34$; $p > .73$), Constructivist Connectivity ($t = -0.42$; $p > .67$), monitoring-evaluation-

planning (t = -.56; $p > .57$), self-efficacy ($t = .17$; $p > .86$), learning risk assessment ($t = —0.27$; $p > .788$), control of concentration ($t = .461$; $p > .64$), and overall metacognitive learning orientations ($t = —0.32$; $p > .75$) were not significantly different.

Table 3. *Post-assessment scores of the control group and the experimental group*

Variables	Treatment	*n*	*M*	*SD*	*t*(28)	*P*
Posttest	MSL	15	34.13	5.34	-.34	.735
	MTB-MLE	15	34.73	4.18		
Constructivist Connectivity	MSL	15	25.53	5.87	-.42	.672
	MTB-MLE	15	26.40	5.19		
Monitoring, Evaluation, Planning	MSL	15	33.46	5.92	-.56	.577
	MTB-MLE	15	34.80	6.97		
Self-Efficacy	MSL	15	23.13	4.25	.178	.860
	MTB-MLE	15	22.86	3.94		
Learning Risk Assessment	MSL	15	17.26	4.80	-.27	.788
	MTB-MLE	15	17.73	4.58		
Control of Concentration	MSL	15	12.26	2.40	.461	.648
	MTB-MLE	15	11.93	1.43		
Overall SEMLIS	MSL	15	111.66	18.13	-.32	.752
	MTB-MLE	15	113.73	17.27		

As shown in Table 4, the ANCOVA confirmed that there were really no significant differences between the post-assessment scores of the MSL group and the MTB-MLE group when their pre-assessment scores were statistically controlled.

Table 4. *Post-assessment scores of the two groups while controlling for pre-assessment scores*

Variable	Approach	Unadjusted		Adjusted		*F*	*p*	η^2
		M	*SD*	*M*	*SE*			
Achievement	MSL	34.13	5.34	34.91	.91	.455	.50	.017
	MTB-MLE	34.73	4.18	33.95	.99			
Constructivist Connectivity	MSL	25.53	5.87	25.08	1.31	.894	.35	.032
	MTB-MLE	26.40	5.19	26.85	1.31			
Monitoring-Evaluation-Planning	MSL	33.46	5.92	33.02	1.67	.841	.36	.030
	MTB-MLE	34.80	6.97	35.23	1.67			
Self-Efficacy	MSL	23.13	4.25	22.28	.873	1.26	.27	.045
	MTB-MLE	22.86	3.94	23.71	.873			
Learning Risk Assessment	MSL	17.26	4.80	16.63	1.17	1.02	.32	.037
	MTB-MLE	17.73	4.58	18.36	1.17			
Control of Concentration	MSL	12.26	2.40	12.24	.52	.150	.70	.006
	MTB-MLE	11.93	1.43	11.95	.52			
Overall	MSL	111.66	18.13	109.07	4.34	1.31	.26	.046
	MTB-MLE	113.73	17.27	116.32	4.34			

It can be gleaned on Table 5 that there was a significant increase on the control group's scores in Science achievement test ($t = —6.14$; $p < .01$), constructivist connectivity ($t = —4.32$; $p < .01$), self-efficacy ($t = —3.17$; $p < .01$) and overall metacognitive learning orientations ($t = —4.55$; $p < .01$) from pre-assessment to post-assessment. However, there was no significant increase in their learning processes such as in monitoring-evaluation-planning ($t = —2.06$; $p < .05$), learning risk assessment ($t = —1.64$; $p > .12$), and control of concentration ($t = —1.92$; $p > .07$).

Table 5. *Pre- and post-assessment scores of the control group*

Variables	Treatment	*n*	*M*	*SD*	*t*(14)	*P*
Achievement	Pre-assessment	15	25.93	6.77	-6.14	.000
	Post-assessment	15	34.13	5.34		
Constructivist Connectivity	Pre-assessment	15	20.06	3.78	-4.32	.001
	Post-assessment	15	25.53	5.87		
Monitoring, Evaluation, Planning	Pre-assessment	15	30.46	7.15	-2.06	.058
	Post-assessment	15	33.46	5.92		
Self-Efficacy	Pre-assessment	15	20.13	5.98	-3.17	.007
	Post-assessment	15	23.13	4.25		
Learning Risk Assessment	Pre-assessment	15	15.86	1.05	-1.64	.122
	Post-assessment	15	17.26	1.24		
Control of Concentration	Pre-assessment	15	10.73	2.34	-1.92	.075
	Post-assessment	15	12.26	2.40		
Overall SEMLIS	Pre-assessment	15	97.26	19.02	-4.55	.000
	Post-assessment	15	111.66	18.13		

Table 6 displays that there was a significant increase in the experimental group's scores in all the variables: Science achievement test (t = —4.05; p < .01), constructivist connectivity (t = —5.52; p < .01), monitoring-evaluation-planning (t = —3.17; p < .01), self-efficacy (t = 4.97; p < .01), learning risk assessment (t = —2.98; p < .05), control of concentration (t = —2.55; p <.05), and overall SEMLIS (t = —4.70; p < .01).

Table 6. *Pre- and post-assessment scores of the experimental group*

Variables	Treatment	*n*	*M*	*SD*	*t*(14)	*P*
Achievement	Pre-assessment	15	29.33	6.51	-4.05	.001
	Post-assessment	15	34.73	4.18		
Constructivist Connectivity	Pre-assessment	15	18.60	4.40	-5.52	.000
	Post-assessment	15	26.40	5.19		
Monitoring, Evaluation, Planning	Pre-assessment	15	27.40	4.10	-3.17	.007
	Post-assessment	15	34.80	6.97		
Self-Efficacy	Pre-assessment	15	16.46	4.94	-4.97	.000
	Post-assessment	15	22.86	3.94		
Learning Risk Assessment	Pre-assessment	15	13.13	3.75	-2.98	.010
	Post-assessment	15	17.73	4.58		
Control of Concentration	Pre-assessment	15	10.20	2.24	-2.55	.023
	Post-assessment	15	11.93	1.43		
Overall SEMLIS	Pre-assessment	15	85.80	13.79	-4.70	.000
	Post-assessment	15	113.73	17.27		

Discussion

This quasi-experimental study tested the effect of MTB-MLE on pupils' achievement, metacognition, self-efficacy, and learning processes in Science by comparing the traits of MTB-MLE learners and MSL learners in Science. Achievement test and the SEMLIS were used to collect the research data. The research assessed whether MTB-MLE was really better than the MSL approach in Science learning. The study checked the equivalence of the two groups by comparing their pre-assessment scores in achievement, metacognition, self-efficacy, and learning processes. This was to eliminate selection bias and ensure that the difference between the groups' post-assessment scores was not due to entry traits, but to the teaching approach where they were exposed to. In a two-month

experiment, the study revealed that there was no significant difference between the Science achievement, metacognition, self-efficacy, and learning processes of the MTB-MLE pupils and the MSL pupils. Meaning, the effectiveness of MTB-MLE and MSL approach on pupils' metacognition, self-efficacy and learning processes was the same.

The current study does not agree with the claims of previous research that MTB-MLE is a better approach (e. g., Awopetu, 2016; Dahm & Angelis, 2019; Han & Park, 2017; Ricablanca, 2014; Mohamed & Lobo, 2019) or an approach that produce lower-level outcomes compared to non-MTB-MLE (e. g., Piper, 2018; Gorjian & Sayyadian, 2017; Vela, 2015; Namanya, 2017). It rejects the claims of previous research that: (a) MSL approach is better than MTB-MLE in comprehending Science lessons (Vela, 2015) or vice versa (Behrmann, 2018); (b) children who are taught using mother tongue have higher mental flexibility processing power and spontaneity (Ramamoorthy, 2020), and higher self-esteem and academic achievement (Tomblin, 2019); (c) MTB-MLE learners feel more comfortable in asking and answering questions, sharing thoughts, and doing things on their own; and (d) MTB-MLE learners foster higher critical thinking skills and control of their learning (Arzadon, 2020). The current research argues that MTB-MLE and MSL approach had the same impact to pupils' Science achievement and metacognitive learning orientations.

Moreover, the study checked if there was a significant increase in the achievement, metacognition, self-efficacy, and learning processes scores of the MTB-MLE group and the MSL group from pre-assessment to post-assessment. This direction was taken into consideration to measure the individual effect of each approach on the pupils. The study found that pupils exposed to MSL approach did not gain statistically significant scores from pre-assessment to post-assessment in learning processes such as monitoring-evaluation-planning, learning risk assessment, and control of concentration, whereas the pupils who received MTB-MLE obtained a significant increase scores in all the variables including the learning processes.

Considering the above-finding, this study supports that MTB-MLE is a recommendable approach if schools want pupils to improve Science achievement, metacognitive skills, and learning processes. MTB-MLE could help pupils achieve significant improvement and metacognitive learning orientations. The study negates the claim that MTB-MLE is a detrimental approach to learning (Mwakira, 2021; Espada et al., 2017; Abrea et al., 2020). On the other hand, it favors that MTB-MLE is a beneficial approach (Perez, 2019; Busari et al., 2018; Ezeokoli & Ugwu, 2019; Beka, 2016; Kioko et al., 2014) most especially to Science learning in the primary levels.

Despite the fact that MSL approach and MTB-MLE created the same level of impact on pupils' achievement and metacognitive learning orientations, their individual effects revealed that MSL approach could not increase the learners' learning processes such as monitoring-evaluation-planning, learning risk assessment, and control of concentration which are highly important strategies in learning Science concepts (Thomas et al., 2008). MTB-MLE, on the other hand, could significantly increase learners' Science traits, be it achievement, metacognition, self-efficacy, or learning processes. Thereby, it is probable that the MTB-MLE pupils could outperform the MSL pupils in the long run in terms of quality of learning outcomes attained. Studies agree that MTB-MLE has the capacity to raise children's learning abilities (Awopetu, 2016), acquisition of science concepts (Busari et al., 2018), class participation and acquisition of concepts for better retention (Ezeokoli & Ugwu, 2019), and academic achievement, self-confidence, and psychological stamina (Beka, 2016). Studies also recorded that MTB-MLE could facilitate pupils' acquisition of their second language (Perez, 2019) and its long-term use in the academe could create return of investment as it has both educational and economic benefits (Kioko et al., 2014).

Implications for policy and practice

Considering that MTB-MLE is a boon in Science Education in the primary level, this study provides some insights that can further enhance the effect of MTB-MLE on the pupils' Science achievement and metacognitive learning orientations.

Redefining MT as learners' contemporary language

Some parents and even teachers in the Philippines argue that children can hardly understand the language used in their books and other learning materials which are claimed as MT-based. It cannot be denied that these uncertainties about the effectiveness of MTB-MLE in the academe originate from the choice of language to be considered as mother tongue (MT). Therefore, to ensure the effectiveness of MTB-MLE, the MT to be employed should be the contemporary language of the learners, and not the MT of their ancestors. The MT should be the language currently understood and spoken by the community where the learners belong, and it does not necessarily entail the use of terminologies of yesterday's generations. The purpose of using MT in school should be to facilitate

the communication of ideas sensitive to the prevailing cultures of the learners, and not to bring back the exact language and cultures of the past. In the case of the Ilocano learners in this study, for instance, their MT which is Ilocano that borrows some Tagalog and even English words should be the language of choice for teaching and learning Science. Basically, teaching in the language easily understood by the learners, which is exactly their MT, is the best way to facilitate communication that eventually leads to successful learning.

Strengthening and intellectualizing MT

Primary schools in different districts should collaborate on discovering and strengthening best practices in the implementation of MTB-MLE. Primary school teachers should consistently share their methods for what works and what does not. They have to continuously support the usage of MTs in their classroom to foster academic MTs and intellectualize the language. Schools should continually encourage additional applications for the MT in academic contexts, as demonstrated in the current study. This is because when children's languages are utilized in other academic activities, they likely learn the importance of their languages.

Capacitating the teachers to MTB-MLE implementation

In-service primary school teachers should attend MTB-MLE-related trainings and seminars at least once a year to keep their knowledge up to date. Similarly, prospective elementary school teachers should have at least a special course that could capacitate them to teach Science using the MTB-ML approach. Most importantly, there should be a specialized curriculum intended for future primary school teachers (e. g. Bachelor in Primary Education or its equivalent) and customized outcome-based criteria for hiring and screening teacher applicants in the primary levels. All primary school teachers should consider enrolling for advance studies, with an emphasis on primary education, child language acquisition, and language learning. Additionally, the Department of Education should enlist the assistance of linguists who can assist teachers in documenting their language for grammar writing and Science dictionary creation, as well as other expert validators who can assist in the production of Big Books and other culturally appropriate reading materials in Science written in their MT.

Monitoring the MTB-MLE implementation

Teachers who are well-trained in MTB-MLE implementation should be assigned to monitor the implementation of MTB-MLE in school districts, and to also train the teachers in their respective districts to effectively implement the said approach. Every school district may organize an association that will guard the effective implementation of MTB-MLE. A periodic convention program that includes friendly search for outstanding MTB-MLE teacher- and school- implementers (without quota of awardees) may be done to sustain good practices on MTB-MLE. This program has to recognize the significant roles of external stakeholders such as the parents and the government officials, in assisting the school toward attaining quality MTB-MLE outcomes.

Disseminating research-based information to stakeholders

Some parents believe that exposing their children to “more” or “pure” English would help them acquire the language faster and more effectively, although a large body of literature affirms that MT is a necessary prerequisite for learning other languages through a process called sequential bilingualism. Perhaps, the said belief is a result of misunderstanding of the importance of MT. Hence, the Department of Education should take the lead in disseminating among the stakeholders the current trustworthy research findings relative to MTB-MLE. Convincing them about the strong rationale for MTB-MLE implementation could elicit an increase level of their involvement for the success of the program.

Conclusions

Although MTB-MLE and MSL approach are comparable in terms of pupils' achievement, metacognition, self-efficacy, and learning processes, MTB-MLE is the approach of choice if schools want to improve pupils’ learning processes which are crucial tools for learning Science concepts. Hence, this study suggests stakeholders especially educationalists to sustain and strengthen the implementation of MTB-MLE in the primary levels since it has the capacity to enhance pupils’ academic achievement and metacognitive learning orientations in the field of Science. Some of the ways to do this include redefining MT as the contemporary language of the learners, intellectualizing MT through continuously applying it to various academic engagements, capacitating the teachers, monitoring the MTB-MLE implementation, and disseminating research-based information to stakeholders.

Further study may verify the current findings by testing the effect of MTB-MLE among other sets of Ilocano Grade III learners in the province. Similar study may also be conducted in the context of ethnic groups such as Ybanag or Itawis pupils. More treatments may be compared e. g., Mother Tongue, Tagalog-Only, English-Only, and Tag-lish. A longer period of investigation with inclusion of different Science lessons is highly suggested to assess for several, long-term outcomes. Researchers are, likewise, urged to employ qualitative research to provide understanding about how MTB-MLE and MLS affect Science achievement and metacognitive learning orientations.

Limitations

This study was conducted in the midst of pandemic where the existing protocols against COVID prohibited face-to-face teaching-learning. The online classes conducted to both groups of learners and the online data collection procedure might influence the validity of the data. Not all learners were present during the online classes and because they were too young, they were being assisted by their guardians to operate the online learning gadgets. Additionally, there was a possibility that the instruction the pupils received from other subjects which were usually taught by their teachers in Tagalog, made their learning acquisitions for both MTBMLE and MLS approaches comparable.

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