The Flipped Classroom: Teaching the Basic Science Process Skills to High-Performing 2nd Grade Students of Miriam College Lower School

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Abstract

Technology has greatly shaped pedagogical practices over time. However scholars posit that the developing technology-aided, -based, and -oriented instructional practices still need scholarly and systematic studies to prove their effectiveness. An emerging teaching strategy that highlights technology tools and programs is Flipped Learning: a strategy where technology redirects learning from large groups to individuals. The research described here hypothesizes that there is a significant difference between the basic science process skills test score means of elementary students in a Flipped classroom and those in a traditional classroom. To test this hypothesis, an experimental design was used as the participants were divided the into two groups: experimental and control. An instructional design was crafted to simultaneously teach both control and experimental groups within a one (1) hour schedule. The experimental group was asked to watch at home researcher-made videos that teach the basic science process skills. In class, these participants deepened understanding of the skills through varied activities. The control group was taught using the traditional method operationalized as 5E Inquiry-Based Model.Both pre- and post-tests were administered to check the relative test scores. A Mann Whitney U test was conducted to evaluate the difference between the basic process skills test mean scores. It is concluded that there is a statistically significant difference (at $\alpha=0.05$, $r = 0.42$) with a large effect size between the two variables.

Keywords: flipped classroom; flipped-learning method; science process skills; STEM education.

Introduction

Technology has drastically changed the educational paradigm in terms of content, pedagogy, and practice. Bishop and Verleger (2013) state that there are two related movements that changed the face of education in the new century. First is the technological movement which "enabled the amplification and duplication of information at an extremely low-cost" (p. 2). The other is the free software movement which allows content to be accessed openly on the Internet. From printed materials, technology has offered countless ways of acquiring information for building knowledge.

As students in the current generation are exposed to technological advancements, there is a great demand for educators to keep up with the trends. This is to avoid disconnection between the experiences inside the classroom and that in real life. The current K-12 Program of the Philippine Department of Education aims to equip graduates with the information, media, and technology skills needed for both school and work. This is a proof that educators of the 21st century learners are compelled to consistently utilize technological tools and programs to carry out and enhance instruction.

An emerging teaching strategy that highlights technology tools and programs is Flipped Learning.

> In a Flipped Learning setting, teachers make lessons available to students to be accessed…Teachers can deliver this instruction by recording and narrating screencasts of work they do on their computers, creating videos of themselves teaching, or curating video lessons from trusted Internet sites. (Hamdan, McKnight, McKnight, & Arfstrom, 2013, p. 4)

Flipped Learning traces its roots in active learning, a process that utilizes various activities which engage the learners at both individual and collaborative levels, transferring the learning responsibility to their own ability and pace (Trantafyllou & Timcenko, 2014; Tucker, 2012).

In the traditional classroom, the bulk of the class time is spent on the students' first exposure to the topic. This exposure may be facilitated through teacher lectures, student-centered activities, or even technology-mediated instruction. In most cases, deeper understanding of concepts is attained at the latter part of lesson. At times, it is achieved through take-home exercises and activities. On the other hand, students in the Flipped classroom receive first exposure to the concepts outside the classroom through online or offline videos. Learners may access the content at home or in school during breaks and dismissal. In this way, face-to-face class time will be spent mostly on attainment of deeper understanding of the concepts.

The purpose of this study is to examine the effectiveness of the Flipped Learning method in teaching the basic science process skills to high-performing 2nd grade students of Miriam College Lower School, an premier exclusive school for girls in the Philippines. Hence, it aims to answer the question, *Is there a significant difference between the basic process skills test score means of the students in the Flipped classroom and in the traditional classroom?* Employing a systematic study of the problem will contribute to the development and utilization of Flipped Learning method in the elementary classroom, a relatively under-researched topic in the study of the emerging technology-enhanced instructional approach.

Literature Review

Defining the Method

Through the efficient use of class time for deepening of concept understanding and skill fluency, the Flipped Learning method may serve as an effective approach to improve retention and learning transfer (Estes, Ingram, & Liu, 2014). Learner retention is better improved in the flipped classroom because the students control their own pace of learning. Unlike in the traditional classroom where the learning pace is dictated by the teacher and strictly followed, learners in the flipped classroom do not receive such pressure to finish at the same time their classmates do.

Flipped Learning attests that lectures are still effective in delivering instruction. In fact, it actually preserves the tenets of traditional pedagogy: engagement/motivation, direct teaching, and evaluation. However, the emerging instructional practice suggests a modification in terms of the first two tenets. It recommends that engagement and direct instruction be implemented in a different manner at a different time, with due respect to learners' capacities to comprehend and retain concepts. Because lectures in a flipped classroom are delivered in a video format to be watched outside class time, learners have the liberty to watch and finish the film whenever and wherever they want. In effect, the students utilize the class time for more productive interactions and engaging activities focused on application and deepening of pre-learned content from the viewed material (Bishop & Verleger, 2013). These implications strengthen the attainment of Flipped Learning's primary objective: to improve the quality and efficiency of the teaching-learning process through maximized class time (Estes, et al, 2014; Demski, 2013; EDUCAUSE Learning Initiative, 2012; New Media Consortium, 2014; Kronholz, 2012; Sparks, 2011).

People may at times associate the Flipped Learning model with online learning and blended learning. These three modes of learning are distinct from one another. Online learning exclusively occurs digitally and does not require face-to-face interaction among teachers and students (Cavanagh, 2012). Virtual class meetings, assignments and lecture happen online through a course management website usually, but not always, asynchronously. On the other hand, blended learning fuses online and face-to-face classes. It has an online element, which may occur during class time (Allen, Seaman, & Garrett, 2007).

Hamdan et al. (2013) mentioned that Flipped Learning is built on four pillars. These are factors that need to be met for the method to occur.

1. **Flexible environments**
   Flexibility in classroom environments varies in many different aspects. In one, teachers may be flexible in the physical structure of the classroom. The re-arrangement of the classroom fixtures may provide for group work, research, performance, and other activities needing personalized space design. . Flexibility may also pertain to assessment. Hamdan et al. (2013, p. 2) further adds that educators may be "flexible in their expectations of student timelines for learning and how students are assessed".

2. **Learning culture shift**
   Because of the deliberate shift in delivering information from the teacher to the students, Flipped learning requires a big change in the pedagogical structure. "Students move from being the product of teaching to the center of learning, where they are

actively involved in knowledge formation through opportunities to participate in and evaluate their learning in a manner that is personally meaningful" (Hamdan et al., 2013, p. 3). This shift also transforms the role of the teacher in the learning process – from being a sage to serving as a guide. (Szparagowski, 2014; Bergmann, Overmyer, & Wilie, 2013). The learning shift may be described as directed towards the constructivism, where the teacher facilitates learning as students discover their own ways of acquiring the knowledge and skills.

3. **Intentional content**
   Planning plays an important role in carrying out the Flipped Learning method. Since video lectures are given ahead of actual interaction, educators must "evaluate what content they need to teach directly" (Hamdan et al., 2013, p. 3). Teachers must also deliberately provide students with effective learning materials that will supplement the video.

4. **Professional educators**
   Critics of the Flipped Learning may posit that since videos are the ones delivering instruction, they may soon "replace" the work of the educators. Hamdan et al. (2013) strongly rejects this speculation. Only professional educators may effectively decide upon when and what to shift instruction from the class to the individual learning space. This testifies that exploring the Flipped Learning does not mean "flipping" all the topics in class. Gojak (2012) even noted that the biggest challenge of the educators is how to utilize the affordances of the model for efficient delivery of instruction.

Advantages and Challenges of Flipped Classrooms

Herreid & Schiller (2013) surveyed a more than 15,000 members of the National Center for Case Study Teaching in Science Listserv to give reasons why "flipping works". The findings of the study proved that the emerging instructional approach provides more opportunities for authentic student scientific research with the increased use of equipment in the classroom. It was also found that make-up work for lessons missed may be facilitated outside the classroom and beyond class time. In addition, teachers also expressed interest and recommendation of Flipped Learning method.

Herreid & Schiller (2013) further mentioned two pressing concerns on the utilization of the Flipped classroom:

1. Since the premise of Flipped Learning transfers the learning responsibility to the students, learners may tend to resist to the new method. They may find it hard to adjust in terms of regulating their study habits outside class time (i.e. watching or reading the material at home or in other places). If they fail to do so, they may end up unprepared as they come to class for the enrichment activities.

2. The materials that are created or curated must be very carefully tailored to the in-class activities so the students feel the homework has validity. Teachers found it difficult to find existing quality videos. If the teachers fail to ensure strong connection between the in-class activities and materials assigned, students may lose interest in the method and may perform less than expected.

A convenient way to "tailor" the video for activities that will be facilitated in class is to actually *create* it. In Flipped learning, videos that students watch may be *created* or *curated*. Videos are created when teachers serve as filmmakers and use appropriate software to produce the video. Creating the videos make Flipped learning more personal to the students as it is their teacher who actually discusses. On the other hand, *curating* the videos means selecting readily available files in various internet platforms. In most cases, links of the curated videos are sent to the students for watching.

In addition to the concerns raised by Herreid & Schiller (2013), Cerrone (2014) also mentioned that internet access at home may be another difficulty. To address this concern, schools in various countries set-up a viewing spot in the classroom or elsewhere in the campus which houses a computer with the copies of the flipped videos. This way, students may watch the video during breaks.

Even if there are concerns raised in the implementation of the Flipped learning method, Bergmann (2012, as cited in Cerrone, 2014, p.9) emphasizes that the success of the strategy "is not in the videos itself, but in the fact that delivering the content in a different way will open up may opportunities for expanded learning in the classroom".

Flipped Learning in Elementary Classrooms

The Flipped Learning method applied in elementary settings is not that explored and researched. It is often employed in intermediate to graduate levels. Its effectiveness in these populations of varying contexts has been proven in a plethora of researches (Zeng, Xiang, Yue, Zeng, Wan, & Zuo, 2017; Lew, 2016; Cerrone, 2014; James, 2014; McLaughlin, Roth, Glatt, Gharkholonarehe, Davidson, Griffin, Esserman, & Mumper, 2014; Estes, 2014; Szparagowski, 2014; Trantafyllou & Timcenko, 2014; Bishop & Verleger, 2013; Herreid & Schiller, 2013, among others). The Flipped Learning method requires higher learning responsibility and basic digital literacy skills. All of which are already developmentally expected of students in the intermediate until graduate levels.

Not much research on Flipped elementary classrooms has been systematically done and documented for scholarly purposes. The demand for personal responsibility and more higher digital literacy skills may impede exploration of the method in lower grades. In the Philippine context for example, it is not until the 4th grade that students are introduced to information and communication technologies (ICT) competencies. The absence or lack of technological-navigational skills of students may contribute to the ineffectiveness or failure of the Flipped classroom method if implemented in these classrooms. This research aims to suggest that the emerging instructional approach may be utilized in the early grades. Setting aside expectations dictated by the curriculum, the familiarity of young learners to technology and their frequent use of it may be enough pre-requisite in carrying out technology-aided, -based, and -oriented classroom practices.

Methodology and Methods

Research Design

An experimental design was employed to test the hypothesis that there is a significant difference between the test score means of the students in the Flipped classroom and the ones in the traditional one. In this research design, there were two groups of participants: control and experimental. Both the groups underwent pre- and post- tests. In between the administration of the two tests, the control group received the traditional instructional method while the experimental group was subjected to the Flipped Classroom method. The independent variables in the research were the two instructional methods while the dependent variables were the test scores of both control and experimental groups.

Research Participants

The proposal for this study was presented to the immediate supervisor of the author to seek approval for conduct. The proposal was approved for implementation. The subjects of the research are the students enrolled in Miriam College Lower School (MCLS) Program for the Development and Enhancement of English, Mathematics, and Science Skills (ProDev+). ProDev+ is a special after-class academic program of MCLS that caters to high-performing Grades Two (2), Four (4), and Five (5) students in the major subjects Reading, Language, Mathematics, and Science. The program is divided into two clusters: English Track (for Language and Reading) and STEM Track (for Mathematics and Science). The objectives of the program are as follows:

1. The students should be able to discover their interests and curiosities in the fields of Communication Arts-English and STEM (Science, Technology, Engineering, and Mathematics) through active participation in various activities.
2. The teachers should be able to provide opportunities for high-achieving students to maximize their potentials through enrichment activities in Communication Arts-English and STEM.

This research is focused on the performance of Grade 2 students in the STEM Track. There were no other Grade Two (2) classes of the same program. Hence, the participants in the sole class are considered as the total population of the research.

Selection Process. The 20% highest performing Grade 2 students in Mathematics and Science (average of both final grade in the previous school year and rating in the past quarter of the current school year) were invited to take the qualifying exam in 2015. The qualifying exam consisted of questions that will be covered in the duration of the whole program. There were a total of 54 students who took the exam. The 24 students who garnered highest scores in the exam were invited to enroll in the program. The number of students selected was the cut-off set by the program proponent. This is to ensure that there is a small teacher to student ratio in the special class.

Determining the Control and Experimental Groups. The researcher employed purposive sampling in determining the students to be included in each of the experimental research groups. The 24 students were ranked according to their program qualifying rating (average of both final grade in the previous grade level and rating in the past quarter of the current school year).

After ranking the students enrolled in the program, the researcher purposively grouped them into two (2) – with both having the near-equal Program Qualifying Rating average of 95.68. Then through balloting, the researcher randomly assigned each group as experimental and control. Below were the results of the assigning process.

Table 1: Determining the Control and Experimental Groups.

Control Group		Experimental Group	
Student	Program Qualifying Rating	Student	Program Qualifying Rating
A	97.88	B	97.63
C	97.46	D	97.33
E	97.00	F	96.83
G	96.79	H	96.75
I	96.46	J	96.33
L	95.46	K	95.63
N	95.08	M	95.33
P	94.79	O	95.08
R	94.63	Q	94.67
T	94.50	S	94.50
V	94.04	U	94.21
W	93.96	X	93.92
Average	95.68	Average	95.67

Data Gathering

The research was conducted over a period of six (6) weeks. The researcher met the class once a week for a one (1) hour session. The six (6) sessions were allotted for the pre-test, intervention method, and post-test.

Methods

A traditional method of instruction was implemented in the control group. It is operationalized at the context of Science and Technology education at Miriam College Lower School. The aforementioned subject area currently utilizes the 5E Inquiry-Based Model of instruction. It enables the students to *engage* in different activities to jumpstart learning and tap prior knowledge, *explore* to build understanding, *explain* to deepen understanding, *elaborate* to extend and apply concepts in real-life, and *evaluate* his/her own learning. On the other hand, the experimental group experienced Flipped Classroom instruction.

The lessons were focused on the development of the basic science process skills which are observing, comparing, measuring, classifying, predicting, and inferring. Observing is the process of gathering information about an object using the five senses of hearing, seeing, smelling, tasting, and feeling. Observations can be classified as *qualitative* and *quantitative*. Qualitative observations use words to describe objects while quantitative observations use numbers and figures. Comparing is the process of studying the similarities and differences of two or more objects. Measuring is the ability to effectively use laboratory tools to arrive at accurate observations. Classifying is the process of sorting and grouping things together according to a specific attribute, quality, or property. Predicting means providing a smart guess on what will happen after a specific event or situation. Inferring means using clues and figures in arriving at sensible details and conclusions.

Before direct instruction, the experimental group was tasked to bring home a compact disc (CD) containing a video about the lesson on the next meeting. In case of technical difficulties with the CD, the group may watch the video online using the link given. The group should watch the video at home and take notes and questions on their notebook. Upon meeting for instruction, the students will engage in a group discussion about the video then perform an Application activity.

Given the two implemented methods, it is assumed by the researcher that lesson plans prepared for both instructional strategies are parallel with each other. Both methods aimed at introducing and evaluating the learning of assigned topic/s for every session. It is only the process that sets the difference between the two strategies. After the conduct of this research, the control group was given copies of the videos that the experimental group utilized. In addition, it was also guaranteed that the performance of participants in the research did not in any way affect their actual performance in the program.

Instructional Design. Each class meeting lasts for one (1) hour from 2:00 – 3:00 PM. The researcher crafted an instructional design that was able to simultaneously address both control and experimental groups within the one (1) hour schedule. The table below describes the lesson flow.

Table 2: Instructional Design.

Control Group	*Schedule*	Experimental Group
Activity		*Activity*
Researcher facilitates the Engage activity and provides instructions for Explore activity.	2:00 – 2:10 PM	Students prepare questions for discussion.
Students perform the Explore activity.	2:10 – 2:30 PM	Researcher facilitates discussion and gives instruction for Application activity.
Researcher facilitates the Explain and Elaborate activities.	2:30 – 2:50 PM	Students perform the Application activity.
Students answer the Evaluate activity.	2:50 – 3:00 PM	Students answer the formative assessment tool. Afterwards, researcher provides instructions for the next Homework.

Data Analysis

The researcher utilized both descriptive and inferential statistics in analyzing the data gathered. The descriptive statistics was used to organize and simplify the data from the test scores of the students. Mann-Whitney Universal (*U*) Test was used to compute for the *U*-values which shall be used to test the hypothesis that there is a significant difference between the basic science process skills test score means of students in the Flipped classroom and in the traditional classroom. Mann-Whitney *U* Test is a non-parametric test which aims to compare difference between two groups with variables that are not normally distributed.

Results and Discussion

Statistical Procedures

A Mann-Whitney *U* test was conducted to evaluate the research hypothesis that there is a significant difference in the basic process skills test mean scores of students in the Flipped classroom and in the traditional classroom. The null hypothesis was also constructed to proceed with the statistical analysis. The two hypotheses were represented below.

Let U_1 = U-value of the experimental group and
U_2 = U-value of the control group.

$$H_0 : U_1 = U_2$$
$$H_a : U_1 \neq U_2$$

In the succeeding tables, the label Group A refers to the experimental group while Group B refers to the control group.

The changed score of each sample in the group was calculated.

Table 3: Changed Scores.

Group A	+6	+14	+8	0	+4	+5	+2	+17	+20	+2	+15	+3
Group B	+3	+5	+6	+7	-4	+5	+3	0	-2	+2	+2	-7

From the list of changed scores, it is important to note that majority (at 11 over a total sample of 12) of the students in the experimental group received a positive change of score from pre- to post- test. This may initially indicate that the method of instruction being tested is successful. On the other hand, a quarter of the sample (at 3 over a total sample of 12) in the control group received a negative change in score from the pre- and post- test. The changed scores were then ranked.

Table 4.1: Rank of Changed Scores.

Group	A	A	A	A	A	B	A	B	A	B	B	A
Changed Score	+20	+17	+15	+14	+8	+7	+6	+6	+5	+5	+5	+4
Rank	1.0	2.0	3.0	4.0	5.0	6.0	7.5	7.5	10.0	10.0	10.0	12.0

Table 4.2: Rank of Changed Scores (cont.).

Group	A	B	B	A	A	B	B	A	B	B	B	B
Changed Score	+3	+3	+3	+2	+2	+2	+2	0	0	-2	-4	-7
Rank	14.0	14.0	14.0	17.5	17.5	17.5	17.5	20.5	20.5	22.0	23.0	24.0

It may be noted that the upper ranks are occupied by students in the experimental group. It is an indication that the highest changes in score from pre- to post- test were garnered by students subjected to manipulation of instructional method.

The rank points were classified according to the groups.

Table 5: Summation of Rank Points.

Group A	1.0	2.0	3.0	4.0	5.0	7.5	$\sum R_1$ =114
	10.0	12.0	14.0	17.5	17.5	20.5	
Group B	6.0	7.5	10.0	10.0	14.0	14.0	$\sum R_2$ =186
	17.5	17.5	20.5	22.0	23.0	24.0	

The medians of the ranks in Group A and B are 8.75 and 15.75, while the means are 9.5 and 15.5 respectively. After running the Mann Whitney *U* test using online software, the following values were obtained.

Table 6: Mann-Whitney *U* Test Results.

Group	*U*	*p*	*z*	*r*
Experimental	108.0	0.0202	-2.05	0.42
Control	36.0	0.0404		

The smaller *U*-value (U_2 = 36.0) was chosen to compare with the *U* critical value of 37.0 at the alpha level of 0.05. This indicates that the null hypothesis must be rejected and the alternative hypotheses be accepted. Flipped classroom method employed in the experimental group held a significant difference in the test scores compared with the control group.

Discussion

The significant difference between the test performance of the students in the two groups widens the scope of Flipped Learning's effectiveness as applied in school settings. To provide a perspective of discussion, a parallel study conducted by scholars in the United States of America may be cited as a benchmark. Ingram, Wiley, Miller, & Wyberg (2014), implemented the Flipped Learning method in 4th and 5th grade Mathematics classes. Results of the study inform that students gained increased interest in the subject area. The participants also expressed desire to have their classes 'Flipped' in the next school year (62% in 4th grade and 59% in 5th grade).

According to Ingram et al. (2014) the Flipped classroom works because "you can rewatch it (the videos) or pause it or fast-forward it but if the teacher was talking in class instead of a video, you cannot do that" (p. 20).

In this particular study of Flipped Learning application in 2nd grade classrooms, several anecdotes from the students in the experimental group were noted by the researcher. The following quotes were noted as the classes went on.

> *Student A*: I enjoy watching the videos at home. I used both the CD and YouTube.
> *Student B*: I already know the lesson today!
> *Student C*: Oh! This (referring to the activity sheet given) is what I saw in the video.
> *Student D*: When are you going to give the next video? I rewatched it many times!

These quotes from students attest to the study of Ingram, et al. (2014) that the method develops within the learners interest and sense of readiness for the lesson. It must also be noted that as the research with 2nd graders ended, the students in the experiemental group expressed desire to continue with watching the videos at home and coming to class for enrichment activities. In this light, Ingram et al. (2014) are validated when they posit that the Flipped Learning method provides for more effective learning dynamics.

However, Ingram et al. (2014) also suggested a possible implication of the Flipped learning method to varying intellectual profiles of learners as they found that low-achieving students expressed difficulty in managing a Flipped classroom. They posit that the method seems to be run in a fast-paced manner. This is an area in the implementation of Flipped learning method that needs to be further researched. In conjecture, this finding of the scholars may not be reflected in this research with 2nd graders mainly because the students enrolled in the program are deemed high-achieving.

Even if there is not a corpus of literature on the implementation of Flipped elementary classrooms, several educators worldwide document their exploration of the method through personal blogs. Van der Eyken (n.d.) of the United Kingdom employs Flipped learning method in his 2nd grade classes and found it effective in terms of capturing and sustaining the interests of the students. He documents his methods through his blog, The Flipped Classroom: Ideas, Resources, and Experiences (https://flippedexperience.blogspot.com). As documented in the blog, Creative Education (https://creativeeducator.tech4learning.com), Doubet (n.d.) of the United States of America explores the method with her Kinder and 1st grade students. Having very young students, Doubet implements a variation of the method, which she calls 'In-class Flipping'. In-class flipping facilitates in school the home activity provision of the authentic Flipped method. This means that the students study the resources in school before teacher proceeds to instruction and enrichment.

There is potential in implementing the Flipped learning method in elementary classrooms. However it is important to take into consideration the differences in learning profiles of younger students compared with those in the intermediate and higher levels. With the high learning responsibility and digital literacy requirements to run the method, younger students must be oriented and instructed properly to yield optimum results.

Conclusion

The objective of the study was to evaluate if there is a difference between the mean scores of two sets of samples on a test of basic science process skills. The first set of samples with n = 12 experienced the Flipped classroom learning method, while the other set with same number of samples were given the traditional classroom method. Both of the groups took pre- and post-tests on basic science process skills. A Mann Whitney *U* test was conducted to evaluate the difference between the basic process skills test mean scores. It is concluded that there is a statistically significant difference with a large effect size between the two variables (mean ranks of Group A and B are 9.5 and 15.5 respectively; $U_1 = 108$ and $U_2 = 36$, $z = -2.08$, $\alpha = 0.05$, upper limit level of significance = 107 and lower limit level of significance = 37, $r = 0.42$).

The results of this research opens an opportunity for scholars to explore a rather under-researched area of application of the Flipped Learning method – in the elementary settings. This research straight-forwardedly concluded that in its contextualized setting, the emerging instructional approach is deemed effective. It is recommended that further studies must be conducted to assess the impact of the approach to the students – their perception and evaluation of outcomes. In addition, studying young students' digital literacy may provide a better understanding of Flipped Learning method's effectiveness and ineffectiveness as applied in the elementary classrooms. It may be deemed that while theoretically, more sophisticated digital literacy skills are needed for flipped classrooms, it may be the innate interest of the students in technology use that possibly entice them to see the approach as effective. After all, young learners now are exposed to technological tools at an early age and they learn to navigate quickly, supervised or unsupervised. These unique characteristics of young learners must be taken advantage of in considering approaches to improve the teaching-learning process.

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