



ArcGIS story maps in improving teachers' Geography awareness

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Abstract

The purpose of this study is to examine the use of story maps in increasing sustainable Geography awareness among Geography teachers. The advent of story maps has altered the current Geography education in the digital era. ArcGIS story maps are a type of user-friendly geospatial technology renewal. This story map is believed capable of helping students learn Geography more independently, transforming Geography education. This belief should be reinforced by implementing story maps on their own Geography teachers, who have low Geography literacy rates in general. This action research involved 67 Geography teachers who were members of the East Java Geography Teacher Working Group, with various backgrounds, ages, and teaching experiences. Learning is implemented using blended learning and the in-on-in model. With blended project-based learning, this research was conducted to solve problems related to high school teachers' low Geography awareness. To identify the effects of the treatment, the obtained data were analyzed using a different test with paired t-test. The findings showed that story maps could increase long-term geographic awareness, illustrated by the obtained significant level of more than 0.05. This success is influenced by teachers' knowledge and experience with geospatial technology, as well as their age. Although the ability to create story projects is limited, the use of story maps provides a meaningful experience for teachers to think, reason, and act geographically.

Keywords: geographic awareness; story maps; geographic teachers

1. Introduction

Teachers carry a substantial role in realizing meaningful learning. They contribute to the success of students' learning by 30%, while the students and learning environment carry 50% and 20% contribution to the learning success (Hattie, 2015). With the essential role of the teacher in the success of the learning, the teachers should be equipped with sufficient skills. Intrinsically, there are three primary factors affecting a teacher's success in teaching, namely technological skills, pedagogical skills, and content knowledge, known as TPACK (Mishra, 2019).

Ideally, teachers should integrate these three components of TPACK into the learning process to achieve great 21st century learning. The integration of TPACK in learning enhances students' academic involvement. Consequently, in Geography learning, the teachers should implement geospatial technology as the pedagogical tools to be the basis for their act and rationale process.

Previous studies suggest that student involvement constructs more effective learning (Glowa, 2016; Goldman, 2017; Egiebor & Foster, 2019). Rapid technology development has

resulted in a more dynamic and uncertain environment. Thus, to help students face this issue, the learning process should implement student centered learning that promotes inquiry-based, STEM, SETS, problem-based, and project-based learning that facilitates active student involvement (Purwaningsih et al., 2020).

As a multidisciplinary field of study, Geography should habituate students to have awareness in developing their geographical understanding (Balderstone, 2006; Johnson et al., 2020). Thus, teachers have to have an integrated geographical understanding. In Geography learning, the students are not only provided data, facts, and concepts, but this learning also accentuates the process of helping students to understand geographical ideas and concepts. Meanwhile, a comprehensive geographical understanding requires an integrated intellectual structure.

Aside from learning the physical condition of an area, consisting of its social, economic, political, and cultural characteristics, in Geography courses, students learn the ways to use that knowledge in formulating actions and rationale. Therefore, geospatial technology is required for processing and comprehending complex geographical information. Besides, a map that is integrated with geospatial technology has been a global primary need, as individuals are connected to social media and online maps daily. Recently, a map is not only used as a Geography learning tool, but it is also needed in learning other disciplines (Vujakovic, 2020; Dumont et al., 2020), reflecting the advance in current Geography learning (Open University, 2016).

In this recent 21st century learning, the teachers are expected to have a high Geography awareness. Story maps are one of the web application based geospatial technology that integrates GIS cloud platforms. It combined digital website maps with various texts, videos, pictures, graphs, and tables, creating a dynamic story. Therefore, these story maps facilitate the effective delivery of learning materials (Strachan & Mitchell, 2014). This story map is deemed to be useful learning media that is capable of enhancing Geography awareness. This story map can improve the Geography awareness of preservice teachers, even if it presents different results in different groups with varying treatments (Lee, 2019).

In addition, a previous study has identified the efficiency of ArcGIS story maps in reinforcing students' higher order thinking skills (HOTS) in the history course (Malek et al., 2020). Linearly, ArcGIS story maps have provided easier access for the public society (Alemy, Hudzik, & Matthews, 2017) and surrounding environment (Gutting, Hübsch, Meinel, & Wende, 2019) to observe the works of an archaeologist. Therefore, story maps carry wide opportunities for Geography teachers to use and develop their creativity (Kallaher & Gamble, 2017). An authentic story presentation invites students to engage with the protagonist emotionally so that they strongly remember the story (Gutting et al., 2019) as they are comfortable (Groshans et al., 2019).

This study focuses on Geography teachers' Geography awareness since the central characteristic and logic of Geography is a spatial discipline required for systematic, authentic, and scientific Geography learning (Lee, 2018, 2019). A deep Geography awareness aids teachers in preparing and independently observing the location, distribution, and correlation between Geography features. However, studies have reported low Geography awareness of Geography teachers in East Java and other areas of Indonesia (Lee, 2018; Purwanto, Utaya, Handoyo, & Bachri, 2020). This low Geography awareness of teachers can be observed from

their specific geographical observation and learning methods. The marginal Geography awareness encourages teachers to approach Geography as a pile of fragmented Geography facts (Loomis, 2019).

The formulation and cultivation of Geography awareness by Geography teachers are essential since they transform Geography learning to be more modern. Geography awareness can present optimum functions that aid teachers in motivating students to develop their geographical observation, spatial thinking, and geographical citizenship (Jo & Bednarz, 2014; Lee, 2018, 2019). As pioneer of changes, Geography teachers should comprehend the advancement of learning technologies following the principles of Geography learning. Similarly, the teachers should also be aware of the benefits being offered by story maps, particularly in accelerating students' Geography knowledge. Recent studies have mostly investigated the potential of story maps in enhancing Geography awareness (Lee, 2019) and the adaptation of new technologies in the Geography courses (Hong & Stonier, 2015). Different from those studies, this study considers the low number of teachers with excellent literacy of geospatial technology. Therefore, this study examines the ability of story maps to enhance the Geography awareness of Geography teachers.

2. Method

2.1. Research Design

This action research used a blended project-based learning design. This research adopted the linear action research with a single cycle implemented on the research participants. There were 67 Geography teachers from the East Java Geography Teacher Working Group were involved as the research participants. The Geography awareness was measured using a test provided before and after the project development. Meanwhile, the project development was carried out online in three stages, namely planning, implementing, and reflecting. In the planning stage, the participants were asked to construct the project model, module, and method. Meanwhile, in the second stage, the in-on-in teacher professional development method was implemented. The detailed implementation of the in-on-in method is described below.

The In stage was completed in two days, involving the ESRI Indonesia. It was carried out through an online workshop using Zoom. The workshop invited a speaker from the industry field from ESRI Indonesia. The speaker discussed the challenges in the application of geospatial technology in Geography learning. Besides, the speaker also introduced story maps as one of the geographic learning platforms in the current digital. On the second day, the participants were asked to practice using story maps. Besides, to help the participants memorize and remember the operational stages, they were also provided with modules and videos. In the last session, the participants were given a project to develop learning materials.

The On stage was carried out in two weeks, with monitoring each week. The monitoring aimed to examine the progress of the participants' projects and help them resolve issues they have faced. In the stage, the participants presented their project. Each participant was given a chance to present their results, while the other participants and the tutors gave input. In addition, the implementation stage is illustrated in Figure 1. Meanwhile, in the reflection stage, the participants reflected on their project results. The project results consisted of the product they had created, posttest, and Geography awareness.

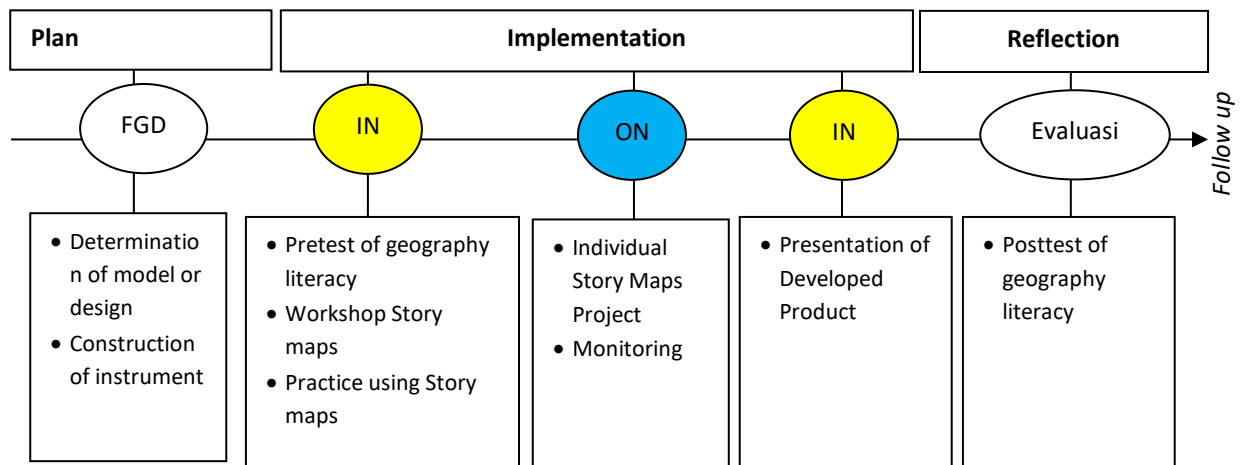


Figure 1. The Implementation Process

2.2. Research Instrument

The project was developed online using a story maps application. The change in Geography awareness was measured using the pretest and posttest. The test instrument consisted of 35 items assessing conceptual knowledge, application, and reasoning based on the Geography perspective. Both the pretest and posttest were carried out online using Google Forms. The geospatial concept was used as it was correlated with participants' knowledge of the concepts of location, distance, time, scale, spatial connection, pattern, and trend. Besides, the geospatial technology adopted in the test was relevant to the ability of participants to operate geospatial tools, such as the geographic information system, remote sensing, Global Position System (GPS), and cartographic knowledge. The reasoning process to answer those items required a problem-solving process following the data, information, and geospatial technology.

2.3. Data Analysis

The data analysis was carried out gradually. Firstly, the pretest and posttest results were tabulated. In the second stage, a normality analysis was completed using One-Sample Kolmogorov-Smirnov Test through SPSS to know if the data had a normal distribution. The data were declared to have normal distribution if their scores >0.05 . In the third stage, a paired-t-test was completed to see if a significant improvement in teachers' Geography awareness had occurred. The learning was considered to affect Geography awareness if it presented a difference of (sig) <0.005 , while the effect was considered significant if it >0.005 .

3. Results and Discussion

3.1. Geography Teachers' Knowledge of and Experience of Using Geospatial Technology

Teachers' Geography awareness was assessed through a survey using a questionnaire. The survey focused on teachers' experiences in using geospatial technology and the types of geospatial technology they frequently used. The survey results showed that 55.6% of teachers

have frequently used geospatial technology, with 28.3% of them have moderately used the technology, while the remaining teachers have no experience in using the technology. The participants' experience in using geospatial technology is illustrated in Figure 2.

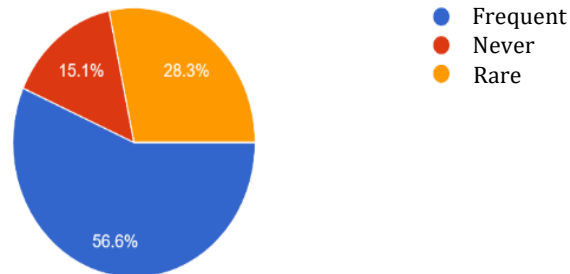


Figure 2. Distribution of Teachers' Experience in Using Geospatial Technology

Teachers with experience in using geospatial technology have better geospatial literacy than those who have no experience in operating it. Besides, the teachers' experiences also affect their Geography awareness.

The second focus of the survey was on the types of geospatial technology frequently used by the participants. Google Map (42.2%) and Google Earth (27.9%) were the two geospatial technology most frequently used by the teachers, aside from remote sensing, SIG, digital map, and other technologies. However, no teachers had ever operated ArcGIS story maps. Thus, this ArcGIS story map integrated with online ArcGIS is deemed to be a relatively new geospatial technology. ArcGIS story maps have been confirmed to be capable of enhancing the Geography awareness of novice teachers through a strict and sustainable workshop (Dong Min Lee, 2020). The types of geospatial technology frequently used by the participant are shown in Figure 3.

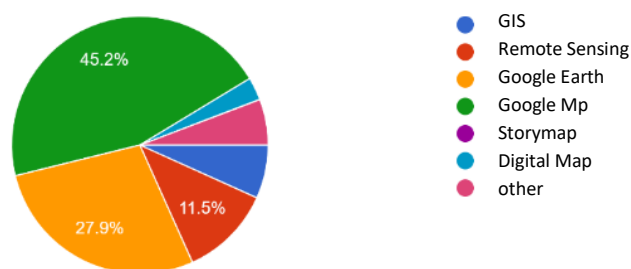


Figure 3. Types of Geospatial Technology Frequently Used by Teachers

Our findings suggest that most of the teachers have experience in using geospatial technology. Their use of geospatial technology is mostly centralized on Google Maps and Google Earth, as these two applications are easily accessible through a smartphone. However, many teachers only implement these two applications as supplementary instruments to help students understand the learning material. It is suggested by 87.5% of teachers who admitted

that they used these two geospatial technologies to support the learning of mapping, SIG, and remote sensing material.

Teachers' limited use of geospatial technologies is caused by their restricted knowledge and operational experience. To ensure that teachers have better knowledge and experience in operating geospatial technology, they need to explore geospatial technology. Geospatial technology can be used and integrated into the learning process to enhance teachers' literacy of geospatial technology, such as ArcGIS story maps.

Teachers' minimum knowledge of ArcGIS story map bears challenges as the technology offers numerous benefits useful to improve the learning process and practically construct teachers' Geography awareness. The ArcGIS story map presents opportunities for teachers to conceptually and procedurally observe, compare, analyze, and organize geographical data based on scientific and geographical methods, as well as geographical theory (Lee, 2019).

3.2. Teachers' Geography Awareness

The Geography awareness was assessed through the pretest and posttest. The test results showed the dynamic of Geography awareness, as illustrated in Figure 4.

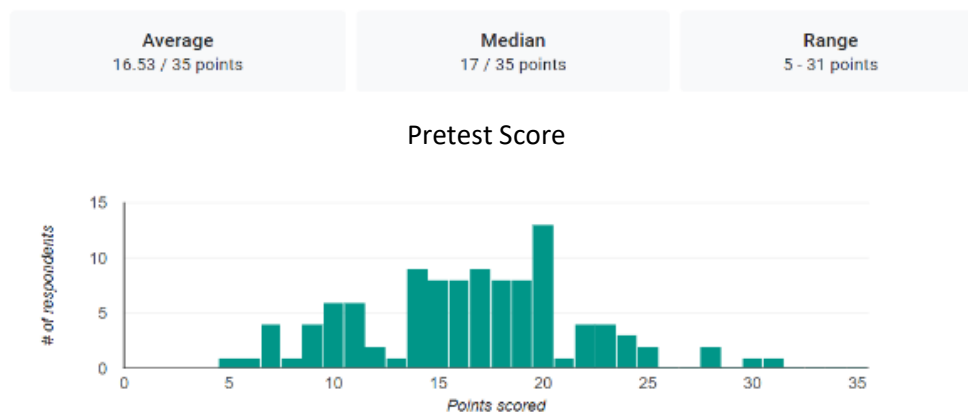


Figure 4. Distribution of Geography Awareness Pretest Score

Figure 4 shows that the participants' initial Geography awareness ranged between 5-31 score. In the pretest, no teachers attained the maximum score. The average correct answer in the pretest was 16.53, below the median score. Thus, the pretest scores showed that the teacher's initial Geography awareness was still low.

In addition, the results of post-test scores, showing the progress of teachers' Geography awareness, are presented in Figure 5. Figure 5 illustrates a specific pattern of Geography awareness distribution. According to the number of correct items, the teachers' Geography awareness was improved. Besides, the obtained lower threshold score was also reduced, from 5 to three. This lower threshold is presumed to be caused by teachers' age since most of our participants are more than 50 years old. The age of these teachers affects their technical mastery, resulting in difficulties in operating the technology. Thus, the implementation of geospatial technology in Geography learning can be challenging. Age differences influence the pace of technological knowledge reception. For the older teachers, even if they possess

excellent experience, they mostly have low technological mastery. Consequently, they require specific accompaniment.

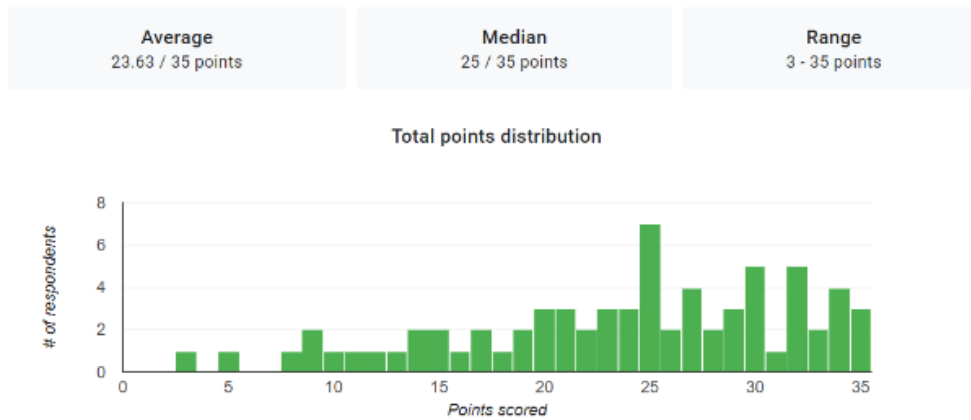


Figure 5. Distribution of Geography Awareness Posttest Score

In addition, the ArcGIS story maps improve teachers' Geography awareness, illustrated by the higher number of teachers' correct answers in the posttest result. In the posttest, some teachers gained the maximum score. Their maximum scores had somehow enhanced the average scores, from 16.53 in the pretest to 23.63 in the posttest. Therefore, it confirms that the ArcGIS story map is capable of improving the teachers' Geography awareness. The comparison of the Geography awareness pretest and the posttest score is illustrated in figure 6.

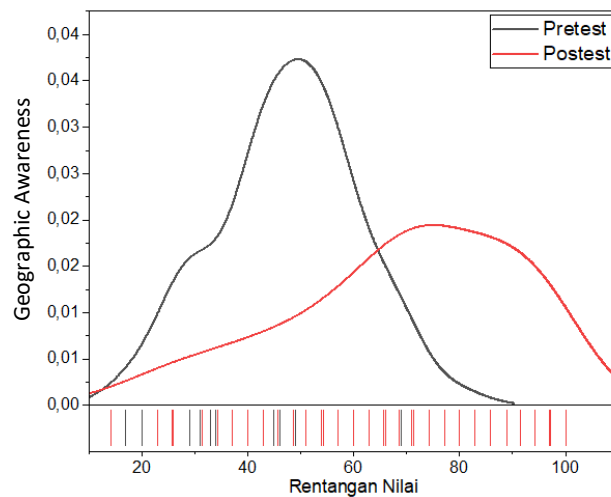


Figure 6. Comparison of Teachers' Geography Awareness

3.3. Enhancement of Teachers' Geography Awareness Using ArcGIS Story Maps

The progression of teachers' Geography awareness was measured by comparing the results of tests completed before and after the blended project-based learning. The results were analyzed using a normality test (Kolmogorov Smirnov) and followed by paired t-test. The Kolmogorov Smirnov compared the data distribution. The results of the normality test are presented in Table 1.

Table 1. Results of Normality Test

One-Sample Kolmogorov-Smirnov Test		
N		Unstandardized Residual 67
Normal Parameters ^{a,b}	Mean	0E-7
	Std. Deviation	12.15266346
	Absolute	.060
Most Extreme Differences	Positive	.060
	Negative	-.058
Kolmogorov-Smirnov Z		.488
Asymp. Sig. (2-tailed)		.971
a. Test distribution is Normal.		
b. Calculated from data.		

The obtained normality test result showed a significant score of $0.971 > 0.05$, showing that the data were normally distributed. Thus, the paired t-test could be carried out. The paired t-test is a parametric test applicable for two paired data. This test aims to identify the different average scores of the paired correlated samples. The results of paired t-test are shown in Table 2, 3, and 4.

Table 2. Results of Paired t-test

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	47.66	67	13.203	1.613
	Posttest	69.46	67	21.479	2.624

Table 3. Results of Paired Samples Correlations

Paired Samples Correlations		
N	Correlation	Sig.
67	.391	.001

Table 4. Results of Paired Sample Test

Paired Samples Test									
		Paired Differences				t	df	Sig. (2-tailed)	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest Posttest	-21.808	20.346	2.486	-26.771	-16.845	-8.773	66	.000

The paired t-test result showed different teachers' Geography awareness knowledge after they used the ArcGIS story map, suggested by the lower average pretest score (47.66) than the posttest score (69.46). Similarly, different standard deviation was also obtained from the pre-test and post-test.

The results of paired t-test suggested different -21.808 average scores between the pretest and posttest, with a standard deviation of 20.346 and a significant level of 0.000. The obtained score of < 0.05 showed different awareness of the Geography teachers before and

after they used story maps. The differences indicate a correlation toward Geography awareness, with a significance level of 0.001. Therefore, the ArcGIS story maps carry effects on the teachers' Geography awareness.

A map is a powerful tool to tell a story, so the current web mapping tool places robust storytelling skills on the students' hands. A story map is one of the strong sets of tools that can be easily used (<http://storymaps.esri.com>). Story maps are a relatively new GIS platform constructed based on cloud Esri and online ArcGIS (Strachan & Mitchell, 2014; Cope et al., 2018). This application enables scientists, educators, and other relevant stakeholders to enhance interactive maps using texts, images, and multimedia content.

This platform enables students to tell their stories through the use of texts, videos, audio, photos, and web maps, directly. Later, these stories can be used as learning instruments to specific assess students' skills mastery. Besides, the story maps gallery also provides various topics, allowing students to establish geographical knowledge. The new story maps appear almost every day (Kerski, 2013). Additionally, story maps can be accessed widely so that the students can be actively involved in the process of creating and using the platform as long as they can access interactive and authentic world models (Egiebor & Foster, 2019; Groshans et al., 2019). The content structure of ArcGIS story maps is thought-provoking as it is capable of communicating and visualizing complex ideas and some pieces of information using an organized and user-friendly interface targeted at particular audiences and courses. The integrated space, place, time, and scale contribute to students' capacity to complete integrated and sustainable learning. Additionally, story maps also give the opportunity for students to visualize and analyze their own narratives and upload them to the website page (Esri, 2021).

Story maps are a suitable friendly geospatial technology for the recent 21st century learning process that should be comprehended by Geography teachers. Therefore, a deep exploration of the use of story maps as a pedagogical tool is essential for sustainable learning. The web-based Story maps may help the teachers to enhance the students' Geography awareness through the integration of interactive maps with texts, pictures, and multimedia content. The recent trend and research highlight the importance of geospatial technology as the current place-based communication tool (Patterson, 2007; Schultz et al., 2008; Patterson & Bickel, 2016).

Geography teachers' direct involvement in using story maps provides immediate experience in using data, information, and geospatial technology. Story maps are one of the geospatial technology evolution products based on the web map. Web map offers wider benefits compared to desktop-based geospatial technology. The web map is a geospatial technology accessible to anyone at any time, requiring only an Internet connection. Therefore, story maps can be used to attain various purposes of Geography learning. Its flexibility enables story maps to be integrated with different media, such as maps, videos, pictures, texts, graphics, tables, augmented reality, virtual reality, IoT, and other digital media.

In addition, the indirect use of story maps improves the users' Geography awareness. It is induced by the story maps' ability to present geospatial information with different models, providing new experiences for teachers to understand Geography. The awareness emerges along with better Geography material mastery. Also, Geography mastery can be defined as someone's ability to understand the essential meaning of a location. Location is key in Geography learning, as it is correlated with other events. Thus, the interactive integration of

maps with narratives, pictures, videos, survey data, and the web using the concepts of space, times, and scale, aids students in understanding the new Geography. Additionally, the use of story maps in the learning process enhances the geo-awareness or spatial rationale, which is expected to be a way to gain career success in the field of science, technology, technique, and mathematics in the 21st century (Kerski, 2015; Robinson et al., 2015). Story maps have been widely used as their successful usage has been extensively confirmed, compared to the use of other geospatial technologies. Its ability to be integrated with numerous media, such as narratives, pictures, videos, web, survey instruments, augmented reality, virtual reality, IoT, and geo-AI positions story maps as an essential tool. Besides, its' ease of use and construction with intuitive design allows it to be used by various stakeholders even though they have minimal or no skills in using maps (Mukherjee, 2019; Mukherjee, 2016). Therefore, story maps can also be used in other disciplines, such as history, sociology, and science (Mukherjee, 2019).

With its numerous benefits, story maps can encourage a deep geographical understanding and awareness of the spatial relation and the processes of the human and physics phenomena, environmental sensitivity, and the comprehension of different knowledge and geographical theory (Egiebor & Foster, 2019; Robinson et al., 2015; Marta & Osso, 2015). The accessibility of story maps can be used widely in various fields. Also, the story maps are deemed to improve students' nationalism on the international topic of the South China Sea (Vujakovic, 2020). The interconnected global location allows students to explore various world issues using a Geography perspective.

Story maps also carry exceptional effects in improving Geography teachers' capacity and awareness of Geography learning. The awareness can be investigated from the different test results with a significant level of 0.00 and a significant correlation of 0.001 from the pretest and posttest data. The results indicate the positive effects of story maps on Geography learning, even if most of our participants have never used them previously. It confirms the adaptability of story maps in enhancing the teachers' Geography awareness, aiding the teachers with no geospatial skills with no difficulties.

The sustainable Geography awareness of the teachers also affects Geography learning as understanding inspires new Geography learning procedures required in the recent eras. The exposure to information technology and communication has opened extensive opportunities for the students to develop their capacity. The geospatial-based learning material helps the teachers to be futuristic Geography teachers. Thus, it motivates the teachers to practice numerous teaching procedures that enable the exploration of geospatial technology as the learning basis. Once a school has these teachers, it will be a model school that inspires other schools to develop and popularize geospatial technology as a pedagogical tool. The connected learning materials with maps announce the importance of Geography learning to students. The introduction of maps using friendly learning media is essential to aid students in developing their critical thinking skills.

4. Conclusion

Our research findings suggest that most Geography teachers (56.6%) have knowledge and experience in using geospatial technology. However, their knowledge and experience remain insufficient to construct their Geography awareness. It is induced by their elemental level of geospatial technology mastery that is only used to support the learning content. This geospatial technology, ArcGIS story maps, can cultivate the teachers' Geography awareness.

Their progressing awareness was shown from the results of the different tests with a significant level of 0.00 and a correlation of 0.001. Thus, our findings suggest that the ArcGIS story maps are relatively adaptive to enhancing Geography awareness. The continuous usage of story maps as a pedagogical tool that supports the learning materials is required. It can also be integrated with the students' daily lives to construct the fundamental of thinking and behaving, as well as to realize sustainable Geography awareness.

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Table 3. Budget Allocation

Cost Component	2016							2017							Total	
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April	May	Jun	Jul		Aug
WBS	₹1,395,000.00			₹1,395,000.00	WBS	₹1,395,000.00			₹1,395,000.00	WBS	₹1,395,000.00			₹1,395,000.00	WBS	₹1,395,000.00
Effort	₹1,000,000.00			₹1,000,000.00	Effort	₹1,000,000.00			₹1,000,000.00	Effort	₹1,000,000.00			₹1,000,000.00	Effort	₹1,000,000.00
Software and Hardware	₹600,000.00	₹100,000.00					₹46900.00									₹1,169,000.00
Subscription	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹82,500.00
Audit															₹100,000.00	₹100,000.00
TOTAL	₹3,000,500.00	₹105,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹474,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹5,500.00	₹105,500.00	₹3,746,500.00