

Culturally Responsive Science Pedagogy through Malay Bardic Stories

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Abstract

The idea of grasping the science lesson through the lens of culture is not new in developed countries as compared to developing and underdeveloped countries. However, the exploration is limited because the exam-orientation in the schooling system converged the science lesson to be curricular-confined. The folk tales, for instance, embodies narratives to illustrate natural objects and phenomena by appreciating the self-hood, cultural identity, and history. This article focuses on the practical instances on Hang Tuah dan Keris Taming Sari and Muntah Jembalang Air dalam Kisah Badang through the lens of scientific inquiries. The sessions were executed as a workshop to encourage learners to understand science lessons beyond the formal curriculum specification. By using the convenient sampling, the reflective analysis was performed. The session started with the storytelling session to foster the participants understanding of the narratives of the folk tales. During the session, the potential of culturally responsive science pedagogy has been discussed in twofold, theory and existing research. Having the context established, this article summarized the reflection from the activities in the light of culturally responsive science pedagogy. Given that this sessions taps a specific group of students, thus the generalizability of this finding to be perpetuated in another context is limited. With limited generalizability, this article shed the practical in application designing the culturally responsive science pedagogy using bardic tales in the future.

Keywords: folk tales, teaching and learning, informal science learning, primary school, multicultural, science curriculum

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Pedagogi Sains Responsif Budaya melalui Cerita Rakyat Melayu

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Abstrak

Idea untuk memahami pelajaran sains melalui lensa budaya bukanlah sesuatu yang baru di negara maju berbanding dengan negara membangun dan kurang membangun. Walau bagaimanapun, penerokaan idea ini adalah terhad kerana orientasi peperiksaan dalam sistem persekolahan cenderung untuk menumpukan pelajaran sains dalam lingkungan kurikulum yang ditetapkan. Cerita rakyat, sebagai contoh, merupakan sumber naratif yang boleh digunakan untuk menggambarkan objek dan fenomena alam dengan mengambil kira nilai-nilai diri, identiti budaya, dan sejarah. Artikel ini menumpukan kepada contoh praktikal penggunaan kisah Hang Tuah dan Keris Taming Sari serta Muntah Jembalang Air dalam Kisah Badang dengan menggunakan pendekatan inkuiri. Sesi pelajaran ini telah dilaksanakan dalam bengkel-bengkel untuk merangsang pelajar dalam memahami pelajaran sains di luar kurikulum formal. Melalui persampelan mudah, kajian reflektif telah dilakukan. Sesi penceritaan cerita rakyat dilakukan untuk memupuk pemahaman peserta tentang cerita rakyat. Semasa sesi ini, potensi pedagogi sains yang responsif kepada budaya telah dibincangkan dalam dua bahagian, iaitu teori dan penyelidikan sedia ada. Selepas konteks ditetapkan, refleksi daripada sesi yang disesuaikan dalam aktiviti ini berdasarkan kepada pedagogi sains yang responsif kepada budaya. Memandangkan sesi ini dijalankan dengan kumpulan pelajar tertentu, kebolehgneralisasian penemuan ini kepada konteks lain adalah terhad dengan cadangan praktikal untuk aplikasi bentuk pedagogi sains yang responsif kepada budaya menggunakan cerita rakyat pada masa akan datang.

Kata Kunci: cerita rakyat, pengajaran dan pembelajaran, pembelajaran sains tidak formal, sekolah rendah, pelbagai budaya, kurikulum sains

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1.0 Introduction

One of the main issues with teaching science to learners is using a methodology that puts the subject matter beyond students' cognitive abilities, leading to a high intrinsic cognitive load (Dahlstrom, 2014). Students struggle to build the requisite schemata to assimilate the material because so much of the science taught bears little similarity to real-world situations (Csikar & Stefaniak, 2018). Thus, knowledge that does not conform to pre-existing schemata is either misunderstood or ignored. The memorization of facts out of memory is one way to make up for a lack of knowledge. Unfortunately, memorizing specific facts separates cognition and prevents knowledge from being applied to new contexts

Culturally responsive science pedagogy is an approach to teaching science that acknowledges and values students' cultural backgrounds. It involves creating a supportive and inclusive learning environment where students feel valued and meaningfully engage with science concepts (Brown, Ring-Whalen, Roehrig, & Ellis, 2018; Garvin, 2016; Marosi, Avraamidou, & Galani, 2021) within their cultural context such as lifestyle, local wisdom, histories and environments. This approach also emphasizes the importance of connecting science to real-world experiences and cultural practices and making connections between science and students' cultural identities. Most of research pertaining the culturally responsive pedagogy refers to the Bronfenbrenner's socio-ecological model (Kourea, Gibson Jr., & Lovelace, 2023) alongside the learning theories. Means that the focus on the culturally responsive pedagogy responded to the humanistic learning in the perspectives of humanistic interaction on the multiple levels of environmental system that influence individual throughout their lives.

Drawing upon the theoretical framework of culturally responsive pedagogy, we posit that integrating culturally relevant content, such as folk tales, into science instruction can enhance students' sense of self-identity, cultural pride, and overall engagement with the subject matter. By situating scientific concepts within familiar cultural contexts, educators can leverage students' existing knowledge and experiences to deepen their understanding of scientific phenomena and promote cross-cultural dialogue.

Several studies proposed that incorporating folklore and bardic storytelling into science education portrays the application of culturally responsive science pedagogy (Gay, 2000, 2002; Hunter-Doniger et al., 2018). Sensing the folklore and bardic story telling through the scientific thinking and scientific knowledge leverages students' cultural backgrounds and experiences to enhance their understanding and engagement with science. Means that, the story telling session encourage the students see the connections between science and their own cultural identities. Subsequently, motivates the students to engage with science content knowledge in a meaningful and relevant way to their experiences (Csikar & Stefaniak, 2018; Matamit et al., 2020; Roslan, 2008). Therefore, incorporating folklore storytelling into science education potentially increases students' engagement, motivation, and cultural sensitivity. Recognizing the potential of cultural narratives to bridge this gap, our study seeks to elucidate how folk tales can serve as powerful vehicles for conveying scientific principles and engaging students in meaningful science learning experiences. The primary aim of this research is to explore the intersection between cultural narratives, particularly folk tales, and science education, with a focus on fostering a culturally responsive pedagogical approach. This article will be reflected on the application of Malay bardic tales as the central point to deliver a simple science concept in informal workshop sessions in different settings. The reflection is drawn from the two different post-workshop reflections from the *Hang Tuah dan Keris Taming Sari* and *Muntah Jembalang Air dalam kisah Badang* in the lens of scientific inquiries.



2.0 Literature Review

Most of the empirical research exploring comprehension and storytelling in the sciences has looked at the use of narratives in science education (eg. Csikar & Stefaniak, 2018; Dahlstrom, 2014; Hunter-Doniger et al., 2018; Matamit et al., 2020; Roslan, 2008). Studies have shown that the use of narratives is more persuasive than the presentation of statistical facts and narratives may counteract the information given in statistical form (Betsch et al., 2011). In other words, the information presented in narrative form is more compelling and believable than statistical evidence. However, there are limited studies on culturally responsive pedagogy focusing on storytelling or exploration of bardic tales. One explanation could be that telling stories is not considered a subject or a style of information presentation that requires scientific rigor (Csikar & Stefaniak, 2018).

In the lens of cognitivism, the culturally-sound storytelling enables listeners to assimilate knowledge and incorporate it into their pre-existing schemata easily. Therefore, it is important to examine storytelling as an alternative method to teaching scientific information to students to improve the contextual meaning behind the complex information and to help construct the necessary schemata to incorporate the information (Csikar & Stefaniak, 2018). Storytelling is a way to increase student engagement, which is positively correlated with learning and information retention (Krupa, 2014; Olson, 2015). Additionally, emotional engagement (i.e. eliciting an emotional response) has also been shown to increase information retention (Lencioni, 2004; Steidl, Razik, & Anderson, 2011).

Therefore students can benefit from stories being used in lesson not only to increase the above-mentioned contextual comprehension of the content knowledge but also to increase their engagement and thereby increasing their learning and retention of the information (Lencioni, 2004; Olson, 2015; Tan et al., 2014). The engagement may even promote learning outside the classroom as students are inspired to continue understanding a topic. Culturally responsive science pedagogy is an approach to teaching that recognizes the cultural backgrounds, experiences, and needs of all students and seeks to incorporate these elements into the classroom in meaningful ways. The bardic tales, for instance, embodies narratives that can simply and imaginatively illustrate natural objects and phenomena (Onodera & Fujii, 2018). Not limited to the folk tales, the exploration of scientific thinking, values, skill, and content through culture also could be manifested through objects (i.e., *batik, labu sayung*), activities, (i.e., *play gasing, kite flying*) and places (i.e., *museum, fisherman village*).

The culturally responsive pedagogy supported by important international policies that serves as the solid ground in global education ecosystem. For example, the United Nations Educational, Scientific and Cultural Organization (UNESCO) has developed the Education for All (EFA) framework (UNESCO, 2000), which promotes the inclusion of diverse cultural perspectives in education and encourages the development of curricula and teaching practices that are relevant and meaningful to students from different cultural backgrounds. The International Baccalaureate Organization (IBO) also has published guidelines for culturally responsive teaching as part of its focus on international-mindedness and intercultural understanding known as IB Education (IBO, 2019). In the similar documents, IB Education also provide guidelines to encourage teachers to reflect on their own cultural ground and to develop teaching practices that are inclusive and responsive to the needs of all students. Several other publications also emphasize the discourse related to policies that focuses on the culturally responsive pedagogy in multiple countries includes United States, India, Malaysia, Indonesia and Japan (i.e.: Halim, Ramli & Ali, 2022; Gay, 2018).

The national policy also resonates with the importance of culturally responsive science pedagogy. The National Culture Policy (Prime Minister Office, 2019) outlines the government's vision for preserving and promoting Malaysia's cultural diversity, including initiatives to support the development of the arts, languages, and cultural industries. The National Heritage Act 2005 (FAO, 2006) aims to



protect and preserve Malaysia's cultural heritage, including tangible and intangible cultural assets such as historical sites, traditional practices, and cultural expressions through education and law. Another important policy that support the education ecosystem of the multiracial society in Malaysia includes is The National Education Act 1996 (ILO, 1996). The National Education Acts 1996 sets out the framework for education in Malaysia, including provisions for the promotion of cultural understanding and appreciation through the school curriculum.

2.1 The *Muntah Jembalang Air* in Badang narratives

Malay bardic tales are a type of folklore that creatively tells local wisdom, geopolitics, social structure, mystical elements, humor, traditions, and taboos in the Malay Language. The oral, written, and symbolism of the narratives have been passed down through many generations among Southeast Asia's indigenous populations (*Nusantara*). The story of Badang, which takes place in Malaysia, Singapore, and Indonesia (Kamari, 2020; Osman & Jalaluddin, 2020) , is an interesting story to explore, especially with children.

The Badang tale is not just limited to literacy; it is also useful in understanding the social structure of certain communities in the past. The concept of slavery in Nusantara is different from how slaves were treated by the colonialists. As such, the story of Badang also justifies the importance of slaves in the social structure of Nusantara. Furthermore, the creative exploration of the *Jembalang Air* vomit in the narrative could be used to teach science process skills and scientific content. Although the story appears mystical and eerie, questioning certain elements in the narrative could encourage children to use evidence to make inferences and relate it to the conclusion. This systematic exploration could scaffold the scientific content through scientific thinking and science process skills (Goh & Abdullah, 2019). The main component in the *Jembalang* vomit could be the semi-digested protein, as it largely consumes protein. Badang low carbohydrate intake due to his inability to work efficiently and his meager rice consumption are highlighted in the narrative. Therefore, Badang consumed a high protein, low carbohydrate diet, and followed it up with intense physical activities that potentially built muscles. Despite being considered an imbalanced diet, when all of the hypothetical evidence is considered, the vomitus works similarly to the nowadays protein shake. The liquid-formed and partially digested components in the vomit help make it much easier to increase Badang's protein intake. In turn, Badang has more muscle buildup and has become stronger.

Having that the Badang tales could be a very good teaching and learning prompt or stimulant to encourage scientific thinking and science process skills. Beyond the excitement in the storytelling activities, drawing upon the hypothetical cause-and-effect relations through scientific content could also encourage the children to explore the elements in the narratives critically. Simultaneously, children will value their selfhood by exploring their folklore and wisdom through the lens of science education.

2.2 The Hang Tuah's *Keris Taming Sari* narratives

In the context of culturally responsive science pedagogy, the story of Keris Taming Sari and Hang Tuah provides an excellent opportunity to explore the scientific properties of alloys and the historical context of the Malacca Sultanate (Braginsky, 2013; Maier, 1999). Children can learn about the scientific properties of alloys and how blacksmiths can imbue them with mystical powers by manipulating their composition. They can explore the characteristics of different metals and how they can be combined to create alloys with unique properties. This exploration can help students understand the physical and chemical properties of metals and how they are used to make tools and weapons. Through this exploration, children can learn about the cultural heritage of the Malay people and the values that are important to their community. This



understanding can promote cultural awareness and sensitivity among students, enabling them to appreciate diverse cultures and perspectives.

The story of Keris Taming Sari not only teaches the importance of bravery and loyalty but also highlights the significance of wisdom and intelligence in warfare. The story also reflects the rich cultural heritage of the Malay people, as the keris is a symbol of Malay identity and tradition. Through storytelling, children can learn about their cultural heritage and the values that are important to their community. Furthermore, the story of Keris Taming Sari can also be used as a stimulus to teach historical and scientific content. Children can explore the historical context of the Malacca Sultanate and its importance in Southeast Asian history. They can also explore the scientific properties of metals and how blacksmiths can imbue them with mystical powers.

Overall, the story of Keris Taming Sari is an excellent example of how culturally responsive science pedagogy can be used to teach local wisdom, history, and scientific content. Through storytelling and exploration, children can learn about their cultural heritage and develop critical thinking skills that will benefit them in all aspects of life.

3.0 Methodology

This study employed a reflective analysis of that were conducted at different locations and by different facilitators. Convenient sampling was used to select the participants of the study (Stratton, 2021). A total of 40 participants from the *Muntah* Badang workshops and 25 participants from Hang Tuah's *Keris Taming Sari* workshop were involved in this study. The sampling criteria were, the participants are Malaysian, attended the national education system, ranging from 8-14 years old children who joined the program voluntarily. The data was collected through the lesson output that were set according to the session objectives. Data from multiple sources, such as observation, photos, and participants' written reflections were analysed and triangulated to provide convergent evidence, complementary insights, increased trustworthiness, and richer contextualization. By combining these different data sources, researchers can strengthen the rigor and credibility of the analysis. Each data source provides a unique perspective and adds different dimensions to the analysis. For instance, observation captures real-time behavior and interactions between the participants and the programme, photos provide visual evidence, and participants' written reflections offer subjective interpretations of their experience. The summary of the program is as below:

Table 1: Comparison of programs

Phase	Program 1	Program 2
Bardic Tales	Hang Tuah's <i>Keris Taming Sari</i>	' <i>Muntah Jembalang Air</i> ' in Badang's Story
Scientific Knowledge	Concept of Alloy in Chemistry Subjects	Concept of Nutrition in Biology Subjects
Pedagogical Approach	Project-based learning	Socratic Inquiries
Lesson Objectives	This session will allow the learner to: <ul style="list-style-type: none"> (a) understand the story behind the <i>Keris Tamingsari</i> (b) relate the story to specific local culture: Sovereignty of the Sultan in Southeast Asia (c) understand the concept of alloy and demonstrate the manipulatives skills in 	This session will allow the learner to: <ul style="list-style-type: none"> a) Understand the story of Badang b) relate the story to specific local culture: Social hierarchy of slavery in Southeast Asia c) understand the concept of nutrition and infer the ingredients by showcasing the scientific thinking d) illustrate the <i>Jembalang</i> based on



	innovating the deliverables (d) make and decorate a paper <i>keris</i>	the characteristics in the story
Culturally responsive science content knowledge	Design, structure, and elements of the keris with the scientific knowledge of alloy	Inferencing the component of the throw outs based on the eating habits, nutritional facts, and the ecosystem.
Tangible output	Art craft: Discover the culturally responsive science content knowledge in alloy making in ancient weaponry	Drawing: Infer the Jembalang Air feature based on its consumed diets, the ecosystem that it lives and the structural details in the storyline

4.0 Discussion

Central to this study are two iconic folk tales: "Hang Tuah dan Keris Taming Sari" and "Muntah Jembalang Air dalam Kisah Badang." These narratives, deeply rooted in Malaysian cultural heritage, offer rich tapestries of storytelling that intertwine natural objects and phenomena with themes of heroism, identity, and history. Through a careful analysis of these folk tales, we have identified conceptual intersections with scientific inquiries, thus providing a compelling rationale for their integration into science education.

In "Hang Tuah dan Keris Taming Sari," for instance, the mythical tale of Hang Tuah's encounter with the enchanted keris (dagger) Taming Sari presents an opportunity to explore principles of material properties. Similarly, "Muntah Jembalang Air dalam Kisah Badang" offers insights into the concept of nutrition focuses on the basic concept of type of nutritions, digestion process and nutrient absorption, and nutrient requirement based on individual conditions. By aligning these folk tales with specific scientific concepts, our study endeavors to demonstrate how culturally embedded narratives can serve as pedagogical tools for enhancing science learning experiences.

Both programs focus on the Malay bardic tales centered upon the storytelling session. The whole session was facilitated to appreciate bardic tales and the science behind the respective stories. In the end, both programs require the participant to transfer their understanding into a tangible product, such as drawings and models. This reflective analysis diverges into two aspects, the strength and the challenges of the program.

Both programs were planned systematically by well-trained facilitators. The storytelling session, therefore, incorporated multimodalities of teaching material. For the first program, the use of digital media for the presentation of the story benefitted to incorporate the video, images, and line-by-line narration to support the participants' understanding about the storyline. Meanwhile, in the second program, the facilitators narrate the storytelling session with text guides. For both sessions, the emotional expression was portrayed to engage the participants with the narratives. The tangible outputs of the session were also a highlight for both programs to learn on how the participants showcase their understanding through drawing and models. The participants followed a series of step-by-step instructions while engaging with the content knowledge towards the completion of the outputs. Means that, alongside the story telling activities, the session was designed to support the development of spatial reasoning skills, fine motor skills, and hand-eye coordination in children, as well as encouraging innovation and creativity.

However, there are several challenges reflected upon. Mapping the scientific content in the curriculum with the narratives is challenging knowing that the stories are embodied with myth and legend. Hence, designing the cultural responsive lesson require a holistic understanding of the context to be related to the scientific content. As such the vagueness and subjectivism in the stories



open for wide interpretation which may deviated from science objectivism. At the same time, the tales perhaps imposed cultural bias as the tales is focuses on Malay context, and however the program was attended by multiracial group of students. Even through a narratives highlighted in the story will not necessarily be converted into a scientific theory, it can be used to enhance learning experiences which challenge the traditional boundaries between 'objective truth' and fiction (Hadzigeorgiou, 2016). On the similar ground, Wallace et al. (2022) agreed that one of the challenges is bridging the gap between abstract scientific concepts and the story that requires making meaningful connections between scientific content and students' lived experiences, interests, and cultural contexts.

Another important reflection from the program implementation is to strike the balance between the story and the scientific content with the duration of the program. Both programs were having too much emphasis on the storytelling, which overshadowed the science content delivery. In the same time, the participants tended to lost their interest and motivation when the science content was related and explained at the end of the story. Similarly, Csikar et al. (2018) also contended that students only recall the overall story without remembering the individual fact when storytelling was used as an instructional strategy in a biology class. Thus, for this case, perhaps the science content, for instance, type of material of the dagger need to be highlighted during the storytelling itself.

As the session was conducted in a heterogenous group, the session was tailored with several individual facilitation to support younger participants. This means that, while learning scientific content using stories showcased the creative pedagogical techniques, the differences among the participants is important to be addressed. The depth of the content knowledge needs to be carefully selected and thought. This study concede that the culturally related storytelling activities is a potentially valuable tool for exploring and making sense of culturally responsive education in science classrooms. This study further support the findings of other studies in different context and settings with their respective challenges of the culturally responsive pedagogy (Csikar & Stefaniak, 2018; Hadzigeorgiou, 2016; Walan, 2019; Wallace et al., 2022). Thus, by leveraging storytelling as a pedagogical strategy, educators can facilitate deeper connections between students' cultural identities and scientific knowledge, thereby promoting a more inclusive and culturally responsive learning environment.

5.0 Conclusion

Culturally responsive pedagogy is an approach to teaching that considers the cultural backgrounds and experiences of students to create a more inclusive and equitable learning environment. This article provides a snapshot of reflection drawn from the application of responsive science pedagogy in two different session that has the potential to make significant contributions to our understanding of how to effectively implement culturally responsive science pedagogy in an informal learning session.

The article reflects on the use of storytelling of a local Malay folklore story entitled '*Hang Tuah dan Keris Tamingsari*' and a hands-on activity to deliver a simple science concept during an after-school holiday program. The concept and examples of the alloy were highlighted in the story, followed by the making of the origami keris at the end of the session. Most participants mentioned they learned about Hang Tuah, the noble values, and the making of the origami keris, implying that most of them were fascinated by the story and the handicraft but unable to recall learning the science concept. This is not a conclusive finding as the is various aspects remains unexplored in study such as the effect of the various factors such as age group, implementation, and the reliability of the participants' reflections.

Thus, a few recommendations are given to further improve the delivery of science content through storytelling in future research. The use of storytelling in science education can be more effective if teachers are committed to providing high-quality instruction in terms of the time spent preparing the



materials, teaching aids, and activities for their students. However, there may be challenges, such as mapping the complexity of the information in the science lesson, diverse age groups, language barriers, and learning environment. Future research should focus on examining the potential benefits of having a more homogenous group of participants regarding their age group, which may facilitate the preparation of the story and improve the participants' understanding of the science concept.

This research offers valuable insights into the design and implementation of culturally responsive science pedagogy using folk tales as a foundational framework. Moving forward, we envision further exploration of this approach across diverse cultural contexts and educational settings. By embracing the cultural wealth inherent in storytelling traditions, educators can create inclusive learning environments where all students feel valued and empowered to engage meaningfully with science.

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