



The Use of Traditional Timorese Media in Project-Based Learning on the Subject of Electronic Configuration in Chemistry

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Abstract: The research question is: How are traditional Timorese houses utilised as a medium for teaching chemistry, and what are the implications, challenges, and impacts? The objective of this study is to investigate the use of traditional Timorese houses as a project-based learning medium for the topic of electron configuration, which has not been extensively explored in the Nusa Tenggara Timur region. The research method employed is a qualitative approach with a case study design. Data analysis was conducted using thematic analysis through six systematic stages. The findings of this study are as follows: Traditional Timorese houses: a). Can be utilised as a medium for chemistry education. b). They have a symbolic relationship with electron configuration material in terms of spatial layout and the number of occupied electron shells. c). Challenges require extra time in guiding students and implementing projects according to their objectives. d). The impact on teachers is to teach students collaboratively between schools and communities, encourage students to be more proactive and innovative, and support school accreditation. The impact on students includes: improved learning outcomes, motivation, critical thinking, and social awareness, becoming more proactive, as well as students' understanding of the material and home culture.

Keywords: Utilisation of Traditional Timorese Media; Project-Based Learning; Chemistry Materials Electron Configuration

Introduction

Building human civilisation through science is a matter of great importance, where universal values such as collaboration, creativity, and cultural relevance are essential to improving the quality of learning. Technological developments have captured students' attention in the classroom learning process (Jannah, Arifrabani, and Aziz 2023) and (Mahyuni et al. 2022). Students' concentration in class has been dominated by developments in media and science (Motoh, Hamna, and Kristina 2022). Therefore, teachers need to develop

more creative learning methods and engage students with learning media (Harpeni Dewantara 2020).

In the context of science education, particularly chemistry, the application of culturally relevant pedagogy is key to enabling students to relate scientific concepts to their local experiences and knowledge(Sa'adah and Asih 2025), thereby making learning more meaningful and contextual (Kim, Kim, and Barnett 2021). The implementation of ethnoscience learning with culture in learning will have an impact on students' critical and analytical thinking skills(Fahrudin, Saputro, and Sarwanto 2023). Teachers need to be

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creative in developing learning media and linking it to the culture of the students' learning environment (Pebriansyah 2020) namely by integrating local cultural elements into classroom teaching (Sibarani 2025). The use of traditional media in learning, often referred to as culturally relevant pedagogy (CRP), can increase student motivation and proactive attitudes. Contextual learning with media that is relevant to students' understanding, diverse cultural perspectives, and personalised content creates a more inclusive and engaging learning environment in the classroom (Herda, Robiasih, and Kozuka 2025).

Learning that uses local cultural media or traditional media has eight benefits for both teachers and students, namely: 1). Increasing student engagement and motivation (Nováková et al. 2021). When chemistry material and teaching methods are connected to students' cultural backgrounds, experiences, and interests, they feel more interested and motivated to learn (Muti'ah et al. 2023) and (Harpeni Dewantara 2020). 2). Improving Conceptual Understanding: When connecting chemistry concepts to cultural contexts, it helps students build bridges between new knowledge and what they already know. Learning becomes more meaningful because students can see the application of chemistry in their daily lives and culture (Tetiwar dan Appulembang 2018). 3). Building a Sense of Belonging and Inclusion: By creating a learning environment that values and celebrates the cultural diversity of students (Winarsih 2017). 4). Improving Self-Confidence and Self-Efficacy: When students see that their cultural knowledge and experiences are valued and integrated into learning (Yalamu, Mahmud, and Chua 2025), their confidence in learning chemistry can increase (Adam 2023). 5). Developing Cultural Competence: Helping students to better understand and appreciate their own culture as well as the cultures of others (Hartono, Hartoyo, dan Hairida 2022). 6). Encouraging Critical Thinking and Social and Political Awareness: Learning can encourage students to analyse social and environmental issues relevant to their communities from a chemical and cultural perspective (Februari 2024). 7). Enhancing Learning Relevance Connecting to cultural contexts (Dewi et al. 2025) makes learning feel more relevant to students' lives and futures (Sari et al. 2024). 8). Supporting Various Learning Styles in Culturally responsive teaching strategies tend to accommodate various learning styles that may be influenced by students' cultural backgrounds (Arifin, Ramdani, and Andayani 2024) and (Nadhiroh dan Ahmadi 2024).

Based on this understanding, project-based learning models are suitable for utilising local or traditional cultural media in the learning process. Tinenti's (2025) research shows that high school students in East Nusa Tenggara like project-based learning models (Tinenti et al. 2025). One of the topics in high

school chemistry is electron configuration, which is often considered abstract and difficult for students to understand. To overcome this challenge, a project-based learning (PjBL) approach that utilises traditional media can be an effective solution, as it allows students to build understanding through collaborative activities and exploration of cultural objects that are familiar in their daily lives (Goldman, Coscia, and Genova 2024). However, there are still problems in the implementation of chemistry education in regions such as East Nusa Tenggara, where limited resources and a lack of integration of local culture into the learning process result in low student engagement and understanding of chemistry concepts, including electron configuration. In addition, the learning media used are often irrelevant to the local cultural context, making it difficult for students to relate the material to their own experiences. Therefore, it is necessary to integrate local cultural knowledge into secondary school chemistry education (Zulyanti, Fadhilah, and Kurniawan 2025).

The steps of the project-based learning model are as follows: 1). Planning and preparation, which consists of: determining learning objectives and competencies, selecting or designing authentic and relevant projects, formulating guiding questions from teachers, planning assessments, organising resources and materials, and forming student learning groups. 2). Project implementation, which includes project orientation and task preparation, planning and organising the project, investigation and research, product development, monitoring, and support. 3). Reporting, which includes presenting and sharing results, product assessment, reflection, and follow-up (Amelia and Aisyah 2021), and (Tinenti et al. 2025).

The characteristics of electron configuration in chemistry are well suited to project-based learning models. Electron configuration refers to the arrangement of electrons within an atom. Electrons, which are negatively charged particles, orbit the atomic nucleus. To simplify understanding, it can be analogised that the atomic nucleus is the Sun, while electrons are the planets orbiting it. Electron configuration is divided into two types. One of them is the electron shell configuration, discovered by Niels Bohr and often referred to as the Bohr electron configuration. According to Bohr, electrons move around the atomic nucleus along specific paths with different energy levels, depending on their position. These paths are then known as atomic shells. According to Bohr's theory, electron filling must begin at the lowest energy level, which is the K shell ($n=1$), followed by the L shell ($n=2$), M shell ($n=3$), N shell ($n=4$), and so on. The maximum number of electrons that can fill each shell is calculated using the formula $2n^2$, where 'n' is the shell number: K shell ($n=1$): $2(1)^2=2$ maximum electrons, L shell ($n=2$): $2(2)^2=8$ maximum electrons, M shell ($n=3$): $2(3)^2=18$ maximum electrons, N shell ($n=4$): $2(4)^2=32$ maximum electrons (Fernanda,

Enawaty, and Rasmawan 2020). The placement of shell K ($n = 1$) followed by shell L ($n = 2$), M ($n = 3$), N ($n = 4$) is almost the same as the position and space of traditional houses in East Nusa Tenggara, which have specific spaces and are cone-shaped. The upper floor at the top, like shell K, is only occupied by special items, the next floor is occupied by skin L with 8 electrons, similar to the second space from the peak in traditional houses, which can only store special items, skin M can only be occupied by 18 electrons, similar to the floor of traditional houses, which typically store food supplies, and the next floor is occupied by skin N with 32 electrons or the remaining electrons from the previous skin. Similarly, in traditional houses, the lower floor is used to store all remaining items or daily necessities, or to store excess food supplies.

The novelty of this study lies in the use of traditional media as a culturally relevant pedagogical tool in project-based learning for the topic of electron configuration, which has not been widely explored in the East Nusa Tenggara region. Previous studies have shown that the integration of local culture in science education can improve knowledge transfer between home and school, strengthen students' cultural identity, and significantly improve scientific concept understanding.(Kim et al. 2021) and (Tinenti et al. 2025). Therefore, the purpose and urgency of this study is to develop a project-based chemistry learning model that utilises traditional media as a bridge between scientific concepts and local culture, to improve students' understanding and engagement in learning about electron configuration in East Nusa Tenggara.

Based on the above description, the problems in this study are: a). How can traditional Timorese houses be used as a medium for teaching chemistry about electron configuration? b). What is the relationship between the subject of electron configuration in chemistry and traditional houses? c). What are the challenges in using traditional houses as a medium for teaching chemistry about electron configuration? d). What is the impact of using traditional houses as a medium for teaching chemistry about electron configuration?

The limitations of this study are as follows: 1). The traditional media in this study is the traditional houses of Timor. 2). The research subjects are limited to three locations, namely the three regencies of Timor Island, namely South Central Timor, North Central Timor, and Belu. The selection of these locations is based on their geographical location and the cultural resources of East Nusa Tenggara that support the research.

Method

Type of research.

The approach used in this study is a qualitative approach with a case study design to explore in depth the use of traditional home media as culturally relevant

pedagogy in project-based learning of electronic configuration chemistry in East Nusa Tenggara. Through this approach, researchers can understand social and cultural phenomena in East Nusa Tenggara and reveal the meaning of cultural values in learning. (Supriandi 2025). The use of case study design allows us to analyze the dynamics, social interactions, and cultural aspects of traditional houses in the students' environment, which have not been explained through quantitative methods. (Albar et al. 2025).

Research location and time.

The research was conducted in three locations in Timor, namely one high school in South Central Timor Regency, one high school in North Central Timor Regency, and one high school in Belu. The selection of these locations was based on their geographical location and the cultural resources of NTT that support the research. The research was conducted from August to November 2024. These locations are known for preserving traditional house customs, and the students have a deep understanding of their cultural values and traditional house customs. Informants from the students were selected using purposive sampling.

Data Collection Methods.

Data collection was conducted using three techniques: interviews, observation, and document analysis to obtain primary and secondary data. Primary data was collected through semi-structured interviews with informants, namely students and chemistry teachers, to gather information on the use of traditional houses as media in project-based learning of chemistry material on electron configuration. Secondary data was collected through observation and documentation. The researcher conducted observations to directly observe learning activities that utilized traditional house media in the teaching of core chemistry material on electron configuration. Document analysis was then conducted through videos, photos, reviewing various notes on traditional houses, miniature traditional houses, and project activity reports.

Data Analysis Techniques

Data analysis was conducted inductively and using thematic analysis. Thematic analysis in this study was used to identify and interpret data related to the participants' life experiences (Braun and Clarke 2012) and (Clarke et al., 2015). Thematic analysis was conducted through six systematic stages. First, researchers familiarised themselves with the data to avoid bias. Then, initial codes were created based on interview questions. The third step was to find initial themes by analysing the data according to predetermined themes. After that, the themes were reviewed and developed. Fifth, the themes are defined and named, followed by the naming of codes according

to the characteristics of the data. Finally, reporting the results is the step of drawing conclusions.

The accuracy and validity of the data in this research apply two main strategies. First, we use source and method triangulation by comparing the results of interviews, observations, and document analysis (Sugiyono 2015). This helps us obtain consistent and reliable data. Second, we conduct member checking; that is, we seek direct confirmation from key informants regarding the interpretation of the data we collect. This step is highly effective in minimising researcher bias. All stages of this research also adhere strictly to ethical principles. This includes obtaining consent from participants before data is collected and ensuring that the confidentiality of respondents' identities is fully maintained (Yumesri et al. 2024).

Result and Discussion

Traditional Timorese houses as a medium for learning chemistry. This finding is based on data from interviews with students and chemistry teachers, showing that the cone-shaped traditional Timorese house has different rooms or floors, each with a specific purpose. The top floor is usually used to store valuable items such as gold and heirlooms. The next floor down is used to store harvest reserves and certain items that are occasionally used in traditional activities. The third floor from the top is usually used to store harvested goods for immediate use or items commonly used for daily needs. It is also often used as a sleeping area or a place to receive important guests. The ground floor or fourth floor is used to store any items to protect them from heat or rain and serves as a relaxation area and play area for children. This is also in line with the results of interviews on this topic, namely: "In the process of planning the creation of a traditional house media project in Belu, there were no obstacles at all. In fact, the students and parents enthusiastically built miniature traditional houses while explaining the meaning of the rooms and structure of traditional Belu houses. The most beneficial aspect of traditional house media is that students design their own miniature traditional house projects, gather historical information from their parents and the community, and then connect the placement of atomic shells in electron configurations". Various studies on the use of traditional houses (Taneo and Madu 2023) as learning media can increase student motivation, understanding (Yunxuan, Ruika, and Ibrahim 2025) and learning outcomes (Sarina and Hasanah 2022), (Melani Putri, Paronda, and Aspikal 2025), (Maria Hedwigis, Sri Sulyistyaningsih, N.D. Tiring 2024) and (Pakaya, Cuga, and Walangadi 2023).

The Relationship Between Chemical Matter, Electron Configuration, and Traditional Houses in Timor. The second finding is that the rooms in traditional Timorese houses have a functional

relationship and placement that is almost identical to the configuration of electrons occupying their respective sub-shells. This is consistent with the interview data, namely: "The concept of chemical matter is very easy to understand. In the K shell, $K = 2n^2 = 2 (1)^2 = 2$ maximum electrons, which is equivalent to the highest position in a traditional house. In the L shell, $L = 2n^2 = 2 (2)^2 = 8$ maximum electrons, which occupies the second space from the top in the traditional house. The K shell $= 2n^2 = 2 (3)^2 = 18$ maximum electrons, for this shell occupies the next space before the free space on the first floor. The K shell $= 2n^2 = 2 (4)^2 = 32$ maximum electrons, which is equivalent to the lowest space in the traditional house that can be occupied by many items and other necessities". Various studies examining the relationship between chemical materials and local culture, such as traditional houses, traditional drinks, and fabric dyeing materials, can be used as practical chemistry materials for students (Suardana 2014), (Maria Hedwigis, Sri Sulyistyaningsih, N.D. Tiring 2024), (Mitarlis, Azizah, and Yonata 2023) and (Aldiansyah et al. 2023). Astuti's (2022) research results on the chemical material of electron configuration are linked to the traditional game of congklak (Astuti and Muna 2022). This shows that chemistry, especially electron configuration, is related to local culture.

Challenges in utilising traditional houses as a medium for chemistry education. This finding was revealed by informants that the challenge in utilising traditional media in project-based learning of chemistry material on electron configuration is managing time outside of class, which requires extra time in guiding students and implementing the project objectives. This is supported by interview data, namely: "We apologise for the delay in implementing the project on electron configuration due to numerous activities at the school". The same thing was mentioned by Taruklimpong (Taruklimpong and Murniarti 2024) that the challenges of chemistry learning in project-based learning are time and teacher readiness. In addition, the challenges of globalisation are distracting students' attention (Aldiansyah et al. 2023) and (Sari, Maryati, and Wilujeng 2023). Therefore, teachers need to manage their time allocation when implementing project-based learning that is linked to local culture.

The impact of utilising traditional houses as a medium for chemistry education. The fourth finding in this study, which is a direct impact of the use of traditional houses as a medium for chemistry learning, is that for teachers, it helps them to teach students collaboratively between schools and the community, helps them to teach students to be more proactive in seeking information both through the internet and through the social environment (Bang 2015), and helps them to be more innovative and support school accreditation (Wuryastuti et al. 2023). This is in line with the interview results, namely: "This excellent medium

can increase students' active participation and make them more proactive in seeking information through the internet, as well as through verbal communication with others. They even create video presentations that are better than mine". Meanwhile, the impact on students inclu(Bang 2015)des: improving learning outcomes, increasing student motivation, encouraging critical thinking and social awareness, increasing student proactivity and involvement in groups, and improving students' understanding of the material and their traditional culture. This is in line with the interview data, namely: "The impact is also that the results of learning chemistry in this material have an average score above 80. Student motivation is very high when calculating electrons in each shell and placing them in a three-storey traditional house up to the top, and I prefer this kind of learning because it is interesting, makes me understand quickly, is not boring, and is not monotonous when studying the material using textbooks". Previous research has been revealed by Aldiansyah et al. (2023) through a literature review that the relationship between chemistry learning and the ethnochemistry approach in Indonesia has a significant impact on teachers themselves and on students (Aldiansyah et al. 2023).



Figure 1. Photos of traditional house miniatures and screenshots of video presentations on electron configuration material. Source: tinenti dkk (Tinenti et al. 2025 ND)

Conclusion

Based on the data and discussion, it can be concluded that: a). Traditional Timorese houses can be used as a medium for learning chemistry. b). Traditional Timorese houses have a symbolic connection with the material of electron configuration, specifically the spatial arrangement and number of electron shells occupied by electrons. c). The challenges in utilising traditional Timorese houses in the learning process include the need for extra time and the readiness of teachers to guide students and implement the project in accordance with its objectives. d). The impact of using traditional houses as a medium for chemistry learning is as follows: for teachers; it helps teachers in teaching students through collaboration between schools and the community,

encourages students to be more proactive in seeking information both through the internet and through the social environment, and helps teachers to be more innovative and support school accreditation. Positive impacts for students include: improving learning outcomes, increasing student motivation, encouraging critical thinking and social awareness, enhancing student proactivity and involvement in groups, and improving students' understanding of the subject matter and the culture of their traditional houses.

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Author Contributions

Yanti R. Tinenti: Conducting field surveys, drafting research proposals, conducting research, drafting reports and discussions, drafting articles for publication

Hironimus Tangi: Assisting the author in conducting research, drafting reports, and drafting articles for publication.

Theresia Wariani: Assisting the author in conducting research, drafting reports, drafting articles for publication.

Visensia H. B. Hayon: Assisting the author in conducting research, compiling reports, compiling articles for publication

Ilidio X. Moreira: Assisting the author in comparing houses in Timor, assisting the author in comparing the functions of traditional houses in Timor, assisting in publication and checking for plagiarism.

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The authors declare no conflict of interest

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