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Grade 7 Natural Science teachers' views of Indigenous Knowledge and how their views influence their classroom pedagogy

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ABSTRACT

This study explored natural science (NS) teachers' views of the nature of indigenous knowledge (IK) for their classroom pedagogy. The research study used Shulman's pedagogical content knowledge (PCK) as a framework, where both the qualitative research approach and a single-case study design were used. The study worked with 6 NS teachers who were invited to fill out the views of nature of IK questionnaire (VNOIK) where science classrooms were used to observe each teacher twice. The study found that most of the NS teachers reflected informed views on IK and that the teachers' views on IK had no influence on their classroom pedagogy. The recommendations drawn from this study included the consideration for the use of learner-centred pedagogies as well as cultural relevance in teaching and curriculum policy alignment. This study contributes to scholarship on IK in science education by highlighting that, although most Natural Science teachers hold informed views of IK, critical gaps remain in their understanding of its experimental and creative dimensions, areas underexplored in South African contexts.

Keywords: Indigenous knowledge, Natural science teachers, Pedagogical content knowledge, Views

INTRODUCTION

The advocacy for science teachers to integrate Indigenous Knowledge (IK) in their science classrooms remains a common feature in post-apartheid South Africa, throughout the new dispensation, from one basic education policy to the next.[1] Furthermore, while the Department of Basic Education (DBE) policies and researchers are explicit about the necessity for the integration of IK into science classrooms, the confusion emanates from the lack of clarity on how science teachers should integrate IK. This lack of clarity contributes to the alienation of indigenous science learners who are deprived of the opportunity to view and do science from a different worldview that is familiar and makes sense to them. Hence, IK is defined as a way of knowing that was advanced by the native community within its environment

[1] Department of Basic Education, *Life Sciences Curriculum and Assessment Policy Statement (CAPS)* (Pretoria: Government Printers, 2011).

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through daily relations, observations, and investigation with their environment.[2] Furthermore, this knowledge draws on its surroundings, spirituality, ethos, and narration and is fundamental and vital for the local people's existence, livelihood, problem-solving, and decision-making. [3]

A study by Mavuru and Ramnarain revealed that Natural Science (NS) teachers who make use of their learners' IK to teach promote positive transformation of their Pedagogical Content Knowledge (PCK).[4] Furthermore, the study discovered that teachers who can decipher their learners' IK can serve as a support for learners who attempt to synchronise the conflict concerning their indigenous perspective and science. Shulman defines PCK as a "pedagogical knowledge which goes beyond knowledge of subject matter per se to the dimension of subject matter knowledge for teaching."[5] Therefore, Reddy suggested that this explanation describes how teachers are expected to assist learners in understanding what they are teaching, which is important for their competency.[6]

This paper does not present a political discourse; instead, it seeks to highlight the integral part played by (1) science teachers' views on IK and (2) the influence their views may have on their PCK to successfully integrate IK in the science classroom.[7] That is to say, according to Mouza et al., is the teacher able to reflect an understanding of the beliefs and presumptions that learners of diverse ages and backgrounds bring with them to the science classroom?[8] This relates to whether the teacher can reflect on both the knowledge of the topics in the subject area and the knowledge of the comprehension of the subject matter by the learners.[9] The sentiments shared by both Shulman and Mouza et al. reflect the teacher's developed or underdeveloped PCK, which questions the teachers' ability to identify the job that needs to be done, identify the correct tools for the job and use the tools correctly. Hence, De Beer, referring to McKinsey's study, which argued "that no schooling system can rise above the limits imposed by the quality of its teachers."[10]

According to Higgins and Moeed, teachers are purportedly skilled persons expected to reflect the expertise on how to arouse science learners' curiosity by using methods that stimulate learners' interest and attention to learn science.[11] However, researchers who looked into science teachers' views and the role these views may play in their PCK found that either the teachers reflect uninformed views or there is no link between their views and the role they play in their PCK, and an intervention was needed.[12] Furthermore, while these studies explored the views of science on IK and their PCK, their

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[2] Everisto Mapedza et al., "Indigenous Knowledge Systems for the Management of the Barotse Flood Plain in Zambia and Their Implications for Policy and Practice in the Developing World," in *Current Directions in Water Scarcity Research*, vol. 4 (Elsevier, 2022), 209–25; Sejabaledi Rankoana, "The Use of Indigenous Knowledge in Subsistence Farming: Implications for Sustainable Agricultural Production in Dikgale Community in Limpopo Province, South Africa," in *Toward a Sustainable Agriculture: Farming Practices and Water Use* (MDPI, 2017), https://doi.org/10.3390/books978-3-03842-331-7-4.

[3] Josef De Beer and Elrina Whitlock, "Indigenous Knowledge in the Life Sciences Classroom: Put on Your de Bono Hats!," *The American Biology Teacher* 71, no. 4 (2009): 209–16; Robby Zidny and Ingo Eilks, "Indigenous Knowledge as a Socio-Cultural Context of Science to Promote Transformative Education for Sustainable Development: A Case Study on the Baduy Community (Indonesia)," 2018, 249–56.

[4] Lydia Mavuru and Umesh Ramnarain, "Teachers' Knowledge and Views on the Use of Learners' Socio-Cultural Background in Teaching Natural Sciences in Grade 9 Township Classes," *African Journal of Research in Mathematics, Science and Technology Education* 21, no. 2 (May 4, 2017): 176–86, https://doi.org/10.1080/18117295.2017.1327239.

[5] Lee S. Shulman, "Those Who Understand: Knowledge Growth in Teaching," *Educational Researcher* 15, no. 2 (February 1, 1986): 9, https://doi.org/10.3102/0013189X015002004.

[6] Camantha Reddy, "The Integration of Indian Indigenous Knowledge into the SA Life Science Curriculum" (North-West University (South Africa), 2019).

[7] Annelize Cronje, Josef de Beer, and Piet Ankiewicz, "The Development and Use of an Instrument to Investigate Science Teachers' Views on Indigenous Knowledge," *African Journal of Research in Mathematics, Science and Technology Education* 19, no. 3 (September 2, 2015): 319–32, https://doi.org/10.1080/10288457.2015.1108567.

[8] Chrystalla Mouza et al., "Investigating the Impact of an Integrated Approach to the Development of Preservice Teachers' Technological Pedagogical Content Knowledge (TPACK)," *Computers & Education* 71 (February 2014): 206–21, https://doi.org/10.1016/j.compedu.2013.09.020.

[9] Mouza et al., "Investigating the Impact of an Integrated Approach to the Development of Preservice Teachers' Technological Pedagogical Content Knowledge (TPACK)"; Shulman, "Those Who Understand: Knowledge Growth in Teaching."

[10] Josef De Beer, "Re-Imagining Science Education in South Africa: The Affordances of Indigenous Knowledge for Self-Directed Learning in the School Curriculum," *Journal for New Generation Sciences* 14, no. 3 (2016): 35.

[11] Joanna, Higgins and Azra Moeed. "Fostering Curiosity in Science Classrooms: Inquiring into Practice Using Cogenerative Dialoguing." Science Education International 28, no. 3 (2017): 190–198. https://doi.org/10.33828/sei.v28.i3.2

[12] Karabo Justice Chuene and Suresh Kamar Singh, "Exploring Science Teachers' Views about the Nature of Science and the Implications on Their Pedagogical Content Knowledge: A Case of 11 in-Service South African Teachers," *Eurasia Journal of Mathematics, Science and Technology Education* 20, no. 1 (January 3, 2024): em2384, https://doi.org/10.29333/ejmste/14090; Eunice

views were of the nature of science (NOS), not IK. The only study known to the researchers that explored teachers' IK views and their PCK was an intervention-based study by Chuene, which focused on Life Sciences teachers, not NS teachers.[13] Other studies involving IK focused on the prospects of integrating IK in a science classroom, teachers' conceptions, the use of IK in a science classroom for sustainability and the integration of IK for decolonisation.[14] As such, the various focus of these studies reflects the gap in the literature on the views of teachers on IK and the influence on their PCK that led to this study. Therefore, the following research question guided this study:

1. What are Grade 7 NS teachers' views on IK?
2. How do Grade 7 NS teachers' views on IK influence their classroom pedagogy?

LITERATURE REVIEW

Education as a basis of human survival helps spread wisdom, knowledge and cultural experiences from one generation to the next by means of preparing people for the current and life to come.[15] Furthermore, in South Africa, NS is taught with almost no connection to real-life context to learners; hence, researchers have advocated for the integration of IK in the NS classroom.[16] By integrating IK, scholars help to link learners with what is learned in classrooms with their daily lives.[17] In so doing, the relevant learning is enhanced through amalgamated learning situations that support both knowledge systems.[18]

Several studies in South Africa explored the prospects of integrating IK in science classrooms, and others explored science teachers' teaching strategies for integrating IK. A study by Khupe on IK and school science, the likelihood for integration revealed that the integration of IK should go beyond facets only relevant to science content, to as far as being considerate of teaching methods and meaningful learning of science.[19] Another study on the prospects and challenges of integrating IK by Madlela revealed that IK presents possibilities such as contextualising the NS curriculum, and it can be used as

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Mthethwa-Kunene, Gilbert Oke Onwu, and Rian de Villiers, "Exploring Biology Teachers' Pedagogical Content Knowledge in the Teaching of Genetics in Swaziland Science Classrooms," *International Journal of Science Education* 37, no. 7 (May 3, 2015): 1140–65, https://doi.org/10.1080/09500693.2015.1022624.

[13] Chuene and Singh, "Exploring Science Teachers' Views about the Nature of Science and the Implications on Their Pedagogical Content Knowledge: A Case of 11 in-Service South African Teachers."

[14] Daimond Dziva, Vongai Mpofu, and Lovemore Kusure, "Teachers' Conception of Indigenous Knowledge in Science Curriculum in the Context of Mberengwa District, Zimbabwe," *African Journal of Education and Technology* 1, no. 3 (2011): 88–102; Rif'ati Dina Handayani, Insih Wilujeng, and Zuhdan K Prasetyo, "Elaborating Indigenous Knowledge in the Science Curriculum for the Cultural Sustainability," *Journal of Teacher Education for Sustainability* 20, no. 2 (December 1, 2018): 74–88, https://doi.org/10.2478/jtes-2018-0016; Benkosi Madlela, "Prospect and Challenges of Integrating Indigenous Knowledge Systems into the Natural Science Curriculum in Schools," *EUREKA: Social and Humanities*, no. 3 (May 31, 2023): 3–19, https://doi.org/10.21303/2504-5571.2023.002867; Caleb Mandikonza, "Integrating Indigenous Knowledge Practices as Context and Concepts for the Learning of Curriculum Science: A Methodological Exploration," *Southern African Journal of Environmental Education* 35, no. 1 (May 14, 2019), https://doi.org/10.4314/sajee.v35i1.13; Maren Seehawer, "South African Science Teachers' Strategies for Integrating Indigenous and Western Knowledges in Their Classes: Practical Lessons in Decolonisation," *Educational Research for Social Change* 7, no. spe (June 1, 2018): 91–110, https://doi.org/10.17159/2221-4070/2018/v7i0a7; Thabelang Segopotse Sefoka and Karabo Justice Chuene, "Life Sciences Learners' Views on the Integration of Indigenous Knowledge into Indigenous Knowledge-Related Topics Using a Cooperative Learning Approach: A Case of South African Grade 10 Classroom," *Eurasia Journal of Mathematics, Science and Technology Education* 21, no. 5 (May 1, 2025): em2633, https://doi.org/10.29333/ejmste/16311.

[15] Rasika Ranasinghe, "The Transmission of Education across Generations: Evidence from Australia," *The B.E. Journal of Economic Analysis & Policy* 15, no. 4 (October 1, 2015): 1893–1917, https://doi.org/10.1515/bejeap-2014-0139.

[16] Cronje, de Beer, and Ankiewicz, "The Development and Use of an Instrument to Investigate Science Teachers' Views on Indigenous Knowledge"; Josef De Beer, "The Affordances of Project-Based Learning and Classroom Action Research in the Teaching and Learning of Natural Sciences," *Perspectives in Education* 37, no. 2 (2019): 67–79; Lizanne De Villiers, Josef De Beer, and Aubrey Golightly, "Problem-Based and Self-Directed Learning Outcomes during an Indigenous Knowledge Intervention for Life Sciences Teachers," in *Towards Effective Teaching and Meaningful Learning in Mathematics, Science and Technology Education: 7th International Conference on Mathematics, Science and Technology Education, ISTE 2016 Proceedings, Kruger National Park, South Africa*, 2016, 505–15; Seehawer, "South African Science Teachers' Strategies for Integrating Indigenous and Western Knowledges in Their Classes: Practical Lessons in Decolonisation."

[17] Ray Barnhardt, "Creating a Place for Indigenous Knowledge in Education: The Alaska Native Knowledge Network," in *Place-Based Education in the Global Age* (Hillsdale, NJ: Lawrence Erlbaum Associates, 2014); Fulvio Mazzocchi, "Under What Conditions May Western Science and Indigenous Knowledge Be Jointly Used and What Does This Really Entail? Insights from a Western Perspectivist Stance," *Social Epistemology* 32, no. 5 (September 3, 2018): 325–37, https://doi.org/10.1080/02691728.2018.1527412.

[18] Janet Chepchirchir Ronoh, "Indigenous Knowledge in the School Curriculum: Teacher Educator Perceptions of Place and Position" (Nelson Mandela University, 2018); Soul Shava, "The Representation of Indigenous Knowledges," 2013, 384–93.

[19] Constance Khupe, "Indigenous Knowledge and School Science: Possibilities for Integration" (University of the Witwatersrand, Faculty of Science, School of Science Education, 2014).

the learners' prior knowledge while promoting diversity in the classroom.[20] Lastly, studies on teachers' strategies for integrating IK and science, and a study on teachers' conceptions of IK in science classrooms revealed a call on the agency of all the community stakeholders, where a bottom-up approach is used and that teachers had limited conceptions about IK and did not perceive IK as useful.[21]

Therefore, it is evident that these studies explored the chances of integrating IK and the benefits thereof, just as other studies from researchers such as De Beer that focused on the use of a relevant teaching approaches.[22] However, these studies are silent on science teachers' views about IK and how influence they have on their pedagogy. That is not to say that studies by Cronje, Reddy and Sebotsa did not attempt to investigate the views of South African science teachers on IK, but their studies were intervention-based studies that sought to train teachers through interventions, as such, different from this study.[23] Therefore, it can be drawn from the aforementioned literature that, while efforts to include IK in a science curriculum are made, one of the key stakeholders, who are science teachers, are not allowed to reflect on which role their views of IK play pedagogically.

Additionally, we say pedagogically because, while we acknowledge that PCK is focussed on "how subject matter is transformed from the teacher's knowledge into the content of instruction", that is, a science teacher must be able to connect the content matter with the relevant and suitable teaching methods.[24] As such, the teachers' pedagogical inclinations are culturally and environmentally embedded and may influence their PCK. Furthermore, several studies have shown that improved epistemological understanding leads to improved PCK. This is evident in studies on enabling factors of science teachers' PCK for NOS conducted by Mesci et al., which found that amidst the intervention, the science teachers improved their understanding of NOS and became capable of ratifying their PCK for integrating NOS.[25] While Alonzo and Kim and Chen and Wei revealed that science teachers' PCK inclination exposes their views of NOS, which can be deduced to informed views of NOS exposing an improved PCK, other studies by Ndeke and Keraro found that science teachers held unformed views of certain tenets of NOS, and their recommendations suggested that introducing developmental courses would improve views of NOS and, by extension, their PCK.[26] Lastly, the fact that this paper's position is not based on literature drawn from IK but NOS is a mere reflection of the scarcity of literature related to teachers' views of IK and their PCK.

THEORETICAL FRAMEWORK

This study is underpinned by PCK, initially coined by Lee Shulman, where he argued that PCK signifies the combination of content and pedagogy into an understanding of how certain topics are planned, represented and adapted to varying abilities of learners and presented for teaching.[27] Furthermore, Shulman proposed three aspects of a teacher with a well-vested PCK; a) The teacher's ability to

[20] Madlela, "Prospect and Challenges of Integrating Indigenous Knowledge Systems into the Natural Science Curriculum in Schools."

[21] Daimond Dziva, Vongai Mpofu, and Lovemore Kusure, "Teachers' Conception of Indigenous Knowledge in Science Curriculum in the Context of Mberengwa District, Zimbabwe," 2011; Seehawer, "South African Science Teachers' Strategies for Integrating Indigenous and Western Knowledges in Their Classes: Practical Lessons in Decolonisation."

[22] De Beer, "The Affordances of Project-Based Learning and Classroom Action Research in the Teaching and Learning of Natural Sciences."

[23] A Cronje, "Epistemological Border-Crossing between Western Science and Indigenous Knowledge and Its Implications for Teacher Professional Development," *Unpublished PhD Thesis, University of Johannesburg*, 2015; Reddy, "The Integration of Indian Indigenous Knowledge into the SA Life Science Curriculum"; T Sebotsa, "Teachers' Lived Experiences of Contextualised Interventions, and Its Affordances for Their Professional Development and for Self-Directed Learning in Physical Sciences" (North-West University (South Africa), 2020).

[24] Shulman, "Those Who Understand: Knowledge Growth in Teaching," 6.

[25] Günkut Mesci, Renee S. Schwartz, and Brandy Ann-Skjold Pleasants, "Enabling Factors of Preservice Science Teachers' Pedagogical Content Knowledge for Nature of Science and Nature of Scientific Inquiry," *Science & Education* 29, no. 2 (April 21, 2020): 263–97, https://doi.org/10.1007/s11191-019-00090-w.

[26] Alicia C. Alonzo and Jiwon Kim, "Declarative and Dynamic Pedagogical Content Knowledge as Elicited through Two Video-Based Interview Methods," *Journal of Research in Science Teaching* 53, no. 8 (October 2016): 1259–86, https://doi.org/10.1002/tea.21271; Bo Chen and Bing Wei, "Examining Chemistry Teachers' Use of Curriculum Materials: In View of Teachers' Pedagogical Content Knowledge," *Chemistry Education Research and Practice* 16, no. 2 (2015): 260–72, https://doi.org/10.1039/C4RP00237G; Grace C. W. Ndeke, Mark I. O. Okere, and Fred N. Keraro, "Secondary School Biology Teachers' Perceptions of Scientific Creativity," *Journal of Education and Learning* 5, no. 1 (December 15, 2015): 31, https://doi.org/10.5539/jel.v5n1p31; Ndeke, Okere, and Keraro, "Secondary School Biology Teachers' Perceptions of Scientific Creativity."

[27] Shulman, "Those Who Understand: Knowledge Growth in Teaching."

understand what makes a topic easy or difficult for learners to understand. b) The teacher's ability to decipher learners' preconceptions and misconceptions despite of their age, culture and background. c) The teacher's knowledge of teaching strategies is likely to be fruitful in reorganising the learners' understanding. Since this study explored the teachers' views of IK and how they influence their classroom pedagogy, these three aspects were used to measure the teachers' classroom pedagogy as follows:

- The teacher's ability to understand what makes a topic easy or difficult for learners to understand. That is to say, while the teacher understands what makes the topic easy or difficult for learners to understand, is the teacher able to use IK to make the lesson more understandable to learners?
- The teacher's ability to decipher learners' preconceptions and misconceptions despite of their age, culture and background. That is to say, is the teacher able to decipher the learners' preconceived ideas and misconceptions, and is the teacher able to use IK to alleviate learners' preconceptions and misconceptions?
- The teacher's knowledge of teaching strategies is likely to be productive in reorganising the understanding. That is to say, can the teacher use the appropriate teaching method to integrate of appropriate IK?

METHODOLOGY

This study used a qualitative research approach, which considers interrelationships between a phenomenon and its context, wherein the researcher uses observations as one of the protocols to collect data. According to Mohajan, this approach allows researchers to explore and determine issues related to certain phenomenon from a view of a person in their natural settings.[28] Hence, the study used a single case study as viewed by Stake, who defined a single case study as a "study of the particularity and complexity of a single case, coming to understand its activity within important circumstances."[29] A case is exclusive, poses domination with supreme importance, and ought to pose a problem to solve with boundaries that help researchers to analyse different participants' views.[30] In the context of this study, the 6 NS teachers who participated in this study served as a single group because they shared a common circuit.

A convenient sampling technique was used to select 6 NS teachers out of the possible 20 because they were affiliated with the Dimamo circuit and were available and interested in participating in the study. This is because convenient sampling involves a sample selected from the part of the population that is in proximity.[31] Furthermore, an open-ended questionnaire named Views on the Nature of Indigenous Knowledge (VNOIK) was administered to the six teachers to complete. The instrument was designed by Cronje et al..[32] It was used to determine the views of South African science teachers about the nature of IK. After the VNOIK was administered to the teachers, non-participant observations were conducted on each teacher twice using an observation schedule that helped to determine if the teachers' views of IK had any implications for their pedagogy.

During data analysis, a deductive coding method was used in which the teachers' answers were given codes according to how they were answered. In other words, as Cronje highlighted, the teachers' answers that reflected uninformed views were coded **UI** and scored **0**. Those that reflected partially-informed views were coded **PI** and scored **1**. Lastly, those who reflected informed views were coded **I** and scored **2**. The teachers' answers were coded using a rubric developed by Cronje.[33] After the answers were coded, the discussions of the NS teachers' answers from the VNOIK was carried out. The data

[28] Haradhan Kumar Mohajan, "Qualitative Research Methodology in Social Sciences and Related Subjects," *Journal of Economic Development, Environment and People* 7, no. 1 (2018): 23–48.
[29] Robert E Stake, "The Art of Case Study Research" (Sage Publications, 1995), xi.
[30] John W Creswell and Cheryl N Poth, *Qualitative Inquiry and Research Design: Choosing among Five Approaches* (Sage publications, 2016); Stake, "The Art of Case Study Research."
[31] Sharan B Merriam, *Qualitative Research and Case Study Applications in Education. Revised and Expanded from" Case Study Research in Education.".* (ERIC, 1998).
[32] Cronje, De Beer, and Ankiewicz, "The Development and Use of an Instrument to Investigate Science Teachers' Views on Indigenous Knowledge."
[33] A Cronje, "Epistemological Border-Crossing between Western Science and Indigenous Knowledge and Its Implications for Teacher Professional Development," *Unpublished PhD Thesis, University of Johannesburg*, 2015, 134-138.

collected from the classroom observations on the 6 teachers who were observed twice each were presented holistically, where only outstanding incidences were deliberated upon using the three tenets as described by Shulman in the theoretical framework section.[34]

Table 1*:* Biographical information of the six NS teachers

Keys: Teachers= T_1 , Male= M, Female= F					
Teachers	**Gender**	**Age (years)**	**Highest qualification**	**Major subjects**	**Teaching experience (Years)**
T_1	M	45	Diploma in Education	Mathematics and Technology	15
T_2	M	27	B.Ed in Senior phase and FET	English and Natural Sciences	4
T_3	F	31	B.Ed in Senior phase and FET	Mathematics and Life Sciences	5
T_4	F	26	B.Ed Hons	Mathematics and Physical Sciences	3
T_5	M	38	Advance Certificate in Teaching	Mathematics, English and Afrikaans	15
T_6	M	40	Advance Certificate in Teaching	Mathematics, Sepedi and Afrikaans	18

Ethical considerations

In this study, an ethical certificate was obtained from the Turfloop Research Ethics Committee (TREC) while the permission to conduct the study at the circuit was granted by the Limpopo Province Department of Education (LDoE). The teachers who participated in this study were requested to complete the informed consent forms. Hence, the teachers' biographical data (see Table 1) is provided above with pseudonyms to protect their identity and strengthen anonymity and confidentiality, where Teacher 1 is coded as T_1.

PRESENTATION AND DISCUSSIONS OF FINDINGS

This section presents, discusses and analyses data drawn from the answers the participating teachers provided on the open-ended questionnaire (VNOIK) and the non-participant observations.

Presentation and analysis of data drawn from the open-ended questionnaire

The teachers were asked to complete the open-ended questionnaire (VNOIK), and below is the presentation of data drawn from the teachers' answers using codes as identified by Cronje, with brief deliberations reflecting how the teachers performed.[35]

Table 2: Summary of coded VNOIK responses of Natural Science teachers

Questions	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Overall score
T_1	I	I	UI	I	PI	I	PI	I	I	I	1.6
T_2	PI	UI	PI	I	PI	PI	I	I	PI	UI	1.1
T_3	UI	I	I	PI	UI	I	I	I	I	I	1.5
T_4	PI	I	I	I	PI	I	PI	I	I	I	1.7
T_5	PI	UI	I	PI	UI	UI	PI	UI	UI	UI	0.5
T_6	PI	UI	PI	PI	PI	I	I	PI	I	UI	1.1
Total UI	1	3	1	0	2	1	0	1	1	3	12
Total PI	4	0	2	3	4	1	3	1	1	0	19
Total I	1	3	3	3	0	4	3	4	4	3	28

Note. Q: Question; I: Informed views(2); PI: Partially=informed views(1); UI: Uninformed views(0)

[34] Shulman, "Those Who Understand: Knowledge Growth in Teaching," 9.

[35] Cronje, "Epistemological Border-Crossing between Western Science and Indigenous Knowledge and Its Implications for Teacher Professional Development."

The overall scores in **Table 2** show that 5 NS teachers' responses suggest that they hold informed views of IK, which accounts for 83% of the NS teachers, while only 1 NS teacher's (T_5) overall score reflects that the teacher holds uninformed views, which accounts for 17% of the participants. The 6 participating teachers managed to jointly attain 28 informed views responses, which account for 47% of the possible 60 responses. Furthermore, the participating NS teachers' total responses that reflected partially-informed views are 19 out of the possible 60, accounting for 32%. Lastly, the teachers managed to achieve 12 responses reflecting uninformed views of IK out of the possible 60, accouunting for 21%. Therefore, the general trend from the data deduced from the table is that the majority of participating NS teachers have informed views about IK.

The segment below discusses some of the outstanding responses given by the participating NS teachers as they attempted to answer the questions from the VNOIK. The participants' answers are either uninformed views or partially-informed views, or informed views. The discussion begins with the participants' answers that reflected uninformed views, followed by those that reflected partially-informed views and concludes with those that reflected informed views.

Outstanding teachers' answers reflecting uninformed views

There are two questions (2 and 10) from the questionnaire for which the majority of the teachers' responses reflected that they hold uninformed views. Question 2 of the questionnaire was focused on whether IK practitioners perform experiments and tests to verify their knowledge. Of the 6 participating teachers, 3 teachers reflected uninformed views. In response to this question

T_5 and **T_6** responses were similar.

> "No, herbalists and healers believe in visions and dreams, because they acquire knowledge from their ancestors."

On the other hand, **T_2** responded by saying:

> "No, because they observe their elders and acquire knowledge from their actions and start applying it to their everyday life."

Although these responses acknowledge the metaphysical nature of IK, IK is passed down from one generation to the next, which De Beer encourages teachers to include while teaching to encourage critical thinking.[36] The responses are in contradiction to the notion that IK is created through practical engagement in everyday life by means of trial-and-error experiences where replications, imitation and rituals are used to strengthen the acquired knowledge that is tested thoroughly in the test site of survival.[37] A tenet Cronje et al. call the "wisdom in action of NOIK"; hence, the participating teachers' responses reflect uninformed views.[38]

In Question 10 of the questionnaire, 3 participating teachers noticeably reflected uninformed views where the question was focused on the use of creativity and imagination by the IK practitioners. In their responses, all three participating teachers (**T_2, T_5** and **T_6**) similarly stated:

> "No, IK cannot be changed or modified because we imitate our parents who took the knowledge from their fore-parents, and we cannot change it because it will not reflect the true roots."

Although the responses of the participating teachers reflected their acknowledgement towards the resilient nature of IK, they did not only reflect uninformed views on the creative nature of IK, but also the tentative nature of IK.[39] Hence, apart from the observations and experiments as the foundations

[36] Catherine Odora Hoppers, "Research on Indigenous Knowledge Systems: The Search for Cognitive Justice," *International Journal of Lifelong Education* 40, no. 4 (July 4, 2021): 310–27, https://doi.org/10.1080/02601370.2021.1966109; De Beer, "The Affordances of Project-Based Learning and Classroom Action Research in the Teaching and Learning of Natural Sciences."

[37] S. G. J. N. Senanayake, "Indigenous Knowledge as a Key to Sustainable Development," *Journal of Agricultural Sciences – Sri Lanka* 2, no. 1 (January 4, 2006): 87–94, https://doi.org/10.4038/jas.v2i1.8117.

[38] Cronje, De Beer, and Ankiewicz, "The Development and Use of an Instrument to Investigate Science Teachers' Views on Indigenous Knowledge," 324.

[39] Cronje, De Beer, and Ankiewicz, "The Development and Use of an Instrument to Investigate Science Teachers' Views on Indigenous Knowledge."

of ways of knowing in IK, creativity, metaphors, myth and imagination play a significant role in the generation of IK, and this aspect is referred to as the creative and the mythical nature of IK.[40]

The outstanding teachers' responses reflect partially-informed views

There are two questions (1 and 5) from the questionnaire, which the majority of the participating teachers' answers reflected partially-informed views. Question 1 sought to determine whether the teachers understood what IK is; 3 of the 6 teachers, 3 stated the following;

T_2: "IK is knowledge gained from home or local community by an individual."

T_5 and **T_6**, on the other hand, defined IK as "a knowledge that is passed from one generation to the next."

These responses are correct; however, each present one limited dimension of what IK is and what it represents. Battiste defined IK as a knowledge that results from cultural philosophies which are community or societally based.[41] Furthermore, IK is viewed as a way of knowing developed by the indigenous community of an area through daily interactions, observations, and experimentation with their surroundings.[42] Therefore, based on the aforementioned definitions, the answers provided by the participating teachers reflect partially-informed views.

In Question 5, there were 4 out of 6 participating teachers whose answers reflected partially-informed views. This question sought to determine if the teachers knew how IK was generated, and two of the teachers' answers were as follows;

T_4 wrote, "It is rooted in history; ancient people used to explore herbs, and they were risk takers."

T_6 also wrote, "They were taught by their forefathers."

The teachers are correct; however, these answers are not explicit about how IK is generated.

Furthermore, IK is generated by practical engagement in everyday life through trial-and-error experiences where repetition, imitation and ceremonies are used as methods to aid retention and reinforce ideas that are rigorously tested in the test-room of persistence.[43] Therefore, when the answers provided by the teachers are juxtaposed with the argument made by the authors, it is deduced that the participating teachers' answers reflected partially-informed views.

The responses of the outstanding teachers reflect informed views

There are three outstanding questions (6, 8 and 9) from the questionnaire in which the responses of the participating teachers reflect informed views. Question 6 sought to determine the teachers' views on how IK can be used to solve contemporary problems. In answering the question, **T_3** stated that "yes, they can solve some of the societal issues because IK is developed through human experiences, and these experiences can help address issues related to them".

T_4 and **T_6** similarly stated that "IK can solve hunger and poverty, because indigenous people used to practice farming, which was essential for food security at a household level".

The views shared by these teachers are in line with research on the role of IK in sustainable development by Sultana found that IK play a significant role in sustainable development, such as " nature conservation, food production, forestry development, medicine, sustainable practices and land."[44] Therefore, drawing from the teachers' responses and these assertions, it can be deduced that the views reflected above are informed.

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[40] Ray Barnhardt, "Indigenous Knowledge Systems and Higher Education: Preparing Alaska Native PhDs for Leadership Roles in Research," *Canadian Journal of Native Education* 31, no. 2 (2008); Cronje, de Beer, and Ankiewicz, "The Development and Use of an Instrument to Investigate Science Teachers' Views on Indigenous Knowledge."

[41] Marie Battiste, "Indigenous Knowledge and the Politics of Education" (Canadian Scholars' Press, 2002).

[42] Mapedza et al., "Indigenous Knowledge Systems for the Management of the Barotse Flood Plain in Zambia and Their Implications for Policy and Practice in the Developing World"; Rankoana, "The Use of Indigenous Knowledge in Subsistence Farming: Implications for Sustainable Agricultural Production in Dikgale Community in Limpopo Province, South Africa."

[43] Ray Barnhardt, "Indigenous Knowledge Systems and Higher Education: Preparing Alaska Native PhDs for Leadership Roles in Research," *Canadian Journal of Native Education* 31, no. 2 (2008); Cronje, "Epistemological Border-Crossing between Western Science and Indigenous Knowledge and Its Implications for Teacher Professional Development"; J.J De Beer and B.-E. Van Wyk, "An Ethnobotanical Survey of the Agter–Hantam, Northern Cape Province, South Africa," *South African Journal of Botany* 77, no. 3 (August 2011): 741–54, https://doi.org/10.1016/j.sajb.2011.03.013..

[44] Shaila Sultana, "Indigenous Ethnic Languages in Bangladesh: Paradoxes of the Multilingual Ecology," *Ethnicities* 23, no. 5 (October 18, 2023): 680–705, https://doi.org/10.1177/14687968211021520.

In Question 8, there were 4 of 6 participating teachers whose responses reflected informed views. The question sought to determine the participating teachers' views on the role played by rituals and myths in IK. In response to this question **T1**, **T2**, **T3** and **T4** agreed that rituals and myths are important in IK, where **T1** provided an example by stating that:

> "The Tsonga community in South Africa discourage young girls from engaging in sexual activities at a tender age by telling them that if they engage in sexual intercourse at an early age, they will lose their hair permanently."

T3 gave an example of discouraging young people from playing in a dam where they might drown by telling them that "the dam has a mermaid that will still them."

In IK, the nature is tangible, partly or generally tested and observed, the experiments are dependent on needs, while the world is orderly, metaphysical and partly predictable.[45] Most importantly, De Beer argued the importance of the metaphysical nature of IK in the classroom as it encourages critical thinking among learners. Hence, the teacher's responses reflected informed views.[46]

In Question 9, there were 4 of 6 participating teachers whose responses reflected informed views. The question sought to determine the views of the participating teachers on the reflection of social and cultural values of certain communities in IK. In response to question **T1**, **T3**, **T4** and **T6** answered the question by saying "*yes*" and the participants provided examples to substantiate their answers. This was evident when

T3 gave an example of China by saying "a Chinese family usually eat from the pots they cook in, and this could be related to their IK."

T4 provided an example drawn from Basotho by saying, "When Basotho families slaughter a cow, they would dry some of the meat to eat later, even when there is a fridge for preservation."

The sentiments shared by these teachers are supported by authors such as Cronje et al., who argued that IK is positioned in cultural tradition, within a certain ancient–dogmatic background and is the result of events linked to everyday life in the natural setting with the community of people who share it, not individuals. Furthermore, it is both locally and ecologically rooted IK, because it is produced in a particular setting by a particular group of people who are the inhabitants of that setting, and it is preserved orally from generation to generation.[47] Therefore, from the answers provided by these teachers and the sentiments shared by the aforementioned authors, it can be deduced that the teachers hold informed views.

Overall comments from the 6 participating NS teachers' answers to the VNOIK

The trends emerging from the teachers' answers showed that most teachers have informed views about IK. This is because the overall average score from their answers is 1.25 out of the possible 2, despite **T5** scoring 0.5, suggesting uninformed views. This trend is similar to findings drawn from Cronje, and Chuene's doctoral studies. Furthermore, the teachers (**T2**; **T5** and **T6**) who reflected uninformed views from question 6 that focused on the use of experiments and tests are the same teachers who reflected uninformed views in question 10 that focused on creativity and imagination.[48]

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[45] Lesley Le Grange, "Integrating Western and Indigenous Knowledge Systems: The Basis for Effective Science Education in South Africa?," *International Review of Education* 53, no. 5–6 (November 8, 2007): 577–91, https://doi.org/10.1007/s11159-007-9056-x; MB Ogunniyi, "The Challenge of Preparing and Equipping Science Teachers in Higher Education to Integrate Scientific and Indigenous Knowledge Systems for Learners," *South African Journal of Higher Education* 18, no. 3 (May 23, 2005), https://doi.org/10.4314/sajhe.v18i3.25498.

[46] De Beer, "The Affordances of Project-Based Learning and Classroom Action Research in the Teaching and Learning of Natural Sciences."

[47] Arun Agrawal, "Dismantling the Divide Between Indigenous and Scientific Knowledge," *Development and Change* 26, no. 3 (July 22, 1995): 413–39, https://doi.org/10.1111/j.1467-7660.1995.tb00560.x; Barnhardt, "Indigenous Knowledge Systems and Higher Education: Preparing Alaska Native PhDs for Leadership Roles in Research"; Erin L. Bohensky and Yiheyis Maru, "Indigenous Knowledge, Science, and Resilience: What Have We Learned from a Decade of International Literature on 'Integration'?," *Ecology and Society* 16, no. 4 (2011): art6, https://doi.org/10.5751/ES-04342-160406.

[48] Cronje, de Beer, and Ankiewicz, "The Development and Use of an Instrument to Investigate Science Teachers' Views on Indigenous Knowledge"; Karabo Justice Chuene, "The Influence of an Intervention on Life Sciences Teachers' Perceptions of the Nature of Science, Indigenous Knowledge and Implications for Their Pedagogy and Self-Directed Learning" (North-West University (South Africa)., 2024).

Presenting and analysing data drawn from the non-participant classroom observations

Non-participant classroom observations were conducted in which each of the 6 teachers was observed twice, each period's duration was sixty minutes, and Shulman's PCK tenets were used to determine if the teachers' views of IK influenced their pedagogy.[49] Each teacher presented their own topic as per the grade taught, and Table 3 shows the topics and other information.

Table 3: Topics, teaching methods and grades taught by the participating NS teachers

Participating Teachers	Grade	Teaching method used during lesson 1 and 2	Topic taught
T_1	7	Lecture method	Energy (Heat transfer and Law of conservation of energy)
T_2	7	Lecture method	Energy (Potential and kinetic energy heat transfer)
T_3	7	Lecture method	Energy (Heat transfer and Law of conservation of energy)
T_4	7	Lecture method	Energy (Potential and kinetic energy heat transfer)
T_5	7	Lecture method	Energy (Potential and kinetic energy heat transfer)
T_6	7	Lecture method	Energy (Heat transfer and Law of conservation of energy)

Typical difficulties that learners face when being taught certain topics, characteristic of their age and culture

This section focuses on the importance of being able to decipher difficulties learners encounter when dealing with certain topics, considering to their age and cultural background. The teachers' 'go to question' in their first lessons was mostly "what is energy?" and while learners were able to explain what energy was. This was against the notion that the teaching of science should use ordinary life and societal experiences to provide meaning to learners.[50] It was clear that the learners' explanation of energy was textbook-based. In some instances, the teachers would ask learners to name the principles of heat energy without allowing learners to differentiate between different types of energy. The learners were able to mention "conduction, radiation and convection"; however, none of the learners attempted to define each principle. Learners should have opportunities to use their IK to make sense of their knowledge, because most IK holders are learners.[51] Thus, the teaching of science cannot be enlightened just by the discipline, but also by the lives of the learners from the community, which should be considered when designing the classroom sessions. Based on the six teachers starting their lessons, it could be concluded that there were no considerations towards the learners' cultural background, age or what could be difficult to understand.

The preconceptions and misconceptions children have, also due to their culture and age

This section focuses on the teachers' ability to address the learners' preconceived ideas and misconceptions despite their age and cultural background. Some of the outstanding moments were during the presentation of the law of conservation when the teachers asked learners, "Can energy be destroyed?" This question was confusing to many learners. This was when **T_3**, **T_4**, **T_5**, and **T_6** were able

[49] Shulman, "Those Who Understand: Knowledge Growth in Teaching."

[50] Robby Zidny, Jesper Sjöström, and Ingo Eilks, "A Multi-Perspective Reflection on How Indigenous Knowledge and Related Ideas Can Improve Science Education for Sustainability," *Science & Education* 29, no. 1 (February 9, 2020): 145–85, https://doi.org/10.1007/s11191-019-00100-x.

[51] Josef De Beer and Elsa Mentz, "Self-Directed Learning: Lessons from Indigenous Knowledge Holders for School Science Education," in *Proceedings of the 7th International Science and Technology Education Conference (ISTE)*, 2016, 23–28; Adri Du Toit, "The Potential of the South African Consumer Studies Curriculum to Foster Indigenous Knowledge," *Journal of Consumer Sciences* 47 (2019).

to rephrase the question "Can energy be finished?". Most of the learners in these classrooms answered yes, and the common reason was that energy is waning when they are tired. Although the teachers were able to explain to the learners that "energy cannot be destroyed but can be converted from one form to another," there were no considerations for learners' age or culture; as such, learners accepted the explanations at face value. Science classes should focus on everyday life and societal circumstances to increase conceptual learning of science and enable learners to appreciate the importance of science.[52] Furthermore, De Beer suggested that culture and school could not be used independently; IK and Western science will complement one another more, especially from the perspective of the learners. Although misconceptions could be identified, no teacher could use the opportunity to assist learners.[53]

Customised approaches devised by teachers to ensure that their lesson is understood well

This section stresses the importance of choosing the appropriate teaching method so that the learners benefit. However, 6 (**T_1**, **T_2**, **T_3**, **T_4**, **T_5**, and **T_6**) of the 6 teachers used the lecture method to teach their lessons. This method limited the teachers in providing a platform for learners to engage and learn from one another. This is because the lessons were more teacher-centred. According to Jacobs et al., pedagogies that promote learner interaction, engagement and are mostly learner-centred allow for proper integration of IK in a science classroom.[54] Furthermore, Jautse et al. (2016) argued that teaching strategies such as cooperative learning prevail in the IK setting. Although Sefoka and Chuene found that De Bono's thinking hats and Jigsaw methods, which are part of the cooperative learning approach, help foster IK and knowledge sharing among learners.[55] Based on the aforementioned literature, it can be deduced that the teaching methods used by the teachers were not conducive to integrating IK and meaningful learning amongst the learners.

Overall comments from the six NS teachers' classroom pedagogy

The emerging trend from the observations is that the teachers were not considerate of the learners' challenges in understanding the topic taught, the consideration of the learners' preconceived ideas and misconceptions, and the use of appropriate teaching methods. Although the CAPS document promotes the integration of IK, it seemed the teachers were more focused on delivering the content, where the lessons were more teacher centred, which appeared to be an impediment to learner participation and engagement.[56]

Two themes emerging from the findings:

- ***The responses of the NS teachers showed that they hold informed views of IK***

The first emerging theme suggested that the majority of NS teachers hold informed views of IK. Although the teachers have informed views, there were two questions (2 and 10) in the questionnaire where teachers (**T_2**, **T_5** and **T_6**) reflected uninformed views, showing that 3 teachers out of six reflected uninformed views. These two questionsrelate to the experimental and testing nature of IK as well as the creative and imaginative nature of IK. This theme is similar to themes drawn from studies by Cronje.[57]

- ***The NS teachers' views of IK had no influence on their classroom pedagogy***

The second theme emerging from the findings showed that none of the teachers' views of IK influenced their classroom pedagogy. This theme further exposed the teacher-centred teaching method that teachers

[52] Edvin Østergaard, "Earth at Rest," *Science & Education* 26, no. 5 (July 4, 2017): 557–82, https://doi.org/10.1007/s11191-017-9906-2.
[53] De Beer, "Re-Imagining Science Education in South Africa: The Affordances of Indigenous Knowledge for Self-Directed Learning in the School Curriculum."
[54] Sander Jacobs et al., "A New Valuation School: Integrating Diverse Values of Nature in Resource and Land Use Decisions," *Ecosystem Services* 22 (2016): 213–20.
[55] Sefoka and Chuene, "Life Sciences Learners' Views on the Integration of Indigenous Knowledge into Indigenous Knowledge-Related Topics Using a Cooperative Learning Approach: A Case of South African Grade 10 Classroom."
[56] Department of Basic Education, *Curriculum and Assessment Policy Statement (CAPS): History Grades 10–12* (Pretoria: DBE, 2011); Kathleen Heugh, "Multilingual Education Policy in South Africa Constrained by Theoretical and Historical Disconnections," *Annual Review of Applied Linguistics* 33 (March 29, 2013): 215–37, https://doi.org/10.1017/S0267190513000135.
[57] Cronje, De Beer, and Ankiewicz, "The Development and Use of an Instrument to Investigate Science Teachers' Views on Indigenous Knowledge."

used, which was not helpful to learners. This theme is similar to themes drawn from the study by Sebotsa.[58]

Discussion Summary

The analysed data drawn from both the VNOIK questionnaire and non-participant classroom observations expose several key insights into the participating Natural Science (NS) teachers' views of IK and how such views influence their pedagogy. Most NS teachers (83%) have informed views on IK, as shown from their overall scores in the VNOIK questionnaire. This suggests that most teachers have a good understanding of IK and its relevance in education. However, there are gaps in their understanding, particularly regarding the experimental nature and the creativity involved in IK, as evidenced by the uninformed views reflected in responses to questions 2 and 10. These gaps indicate a need for further professional development to deepen their understanding of IK's dynamic and creative aspects. Despite having informed views of IK, the teachers' classroom practices did not effectively reflect these views. The exclusive use of the lecture method in all observed lessons limited opportunities for learner engagement, interaction, and the integration of IK into the lessons. Furthermore, the teachers did not adequately consider the learners' cultural backgrounds, age, or preconceptions, which are crucial factors in designing effective science lessons that resonate with learners' IK. This lack of consideration likely hindered the learners' ability to relate to and fully understand the topic taught. These approaches missed opportunities to enrich the learning experience by connecting IK with the science curriculum. The contribution of this study expands the pedagogical scholarship by showing a disconnect between teachers' informed views on IK and their classroom practices by exposing the teachers'over-reliance on lecture methods. As such, not integrating learners' cultural backgrounds add nuanced evidence on why policy-driven IK integration is not being realised in practice.

From a theoretical standpoint, the study advances PCK scholarship by demonstrating that teachers' knowledge of IK does not necessarily translate into pedagogical action. This reinforces the importance of professional development programmes that address both conceptual understanding and classroom application of IK to foster culturally responsive and learner-centred science teaching.

RECOMMENDATIONS

The recommendations drawn from this study include consideration of learner-centred pedagogies and cultural relevance in teaching and curriculum policy alignment. These recommendations aim to bridge the gap between the teachers' understanding of IK and their classroom practices, ultimately fostering a more inclusive and engaging learning environment for learners. Firstly, teachers should be encouraged to use learner-centred teaching methods, such as problem-based learning and the jigsaw method, which allow greater integration of IK and promote active learner engagement and would enable students to connect their IK with scientific concepts more meaningfully. Secondly, there should be development of teaching strategies that are culturally responsive and take into account the learners' backgrounds, preconceptions, and misconceptions. This could include using more examples from the learners' communities and daily lives, thus making science lessons more relatable and impactful. Lastly, the integration of IK into the curriculum is not only a policy requirement but also reflected in classroom practice. This might involve revisiting the CAPS document to provide more explicit guidelines and examples on how IK can be incorporated into daily teaching practices.

CONCLUSION

The study explored Natural Science teachers' views of IK and how these views influenced their classroom pedagogy. The findings revealed that while most teachers had informed views of IK, misconceptions persisted regarding its experimental and creative nature. More importantly, these views did not translate into classroom practice, as the teachers predominantly used lecture methods and neglected learners' cultural backgrounds, age-related challenges, and misconceptions. This disconnect between teachers' views and their pedagogy suggests that have knowledge of IK is insufficient without

[58] Sebotsa, "Teachers' Lived Experiences of Contextualised Interventions, and Its Affordances for Their Professional Development and for Self-Directed Learning in Physical Sciences."

the pedagogical competence to integrate it meaningfully. Therefore, the study concludes that effective integration of IK in science education requires not only strengthening teachers' conceptual understanding of IK but also equipping them with learner-centred and culturally responsive pedagogical strategies.

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