Article

Investigating Dialogical Argumentation and Assessment for Learning as Instructional Model for Teaching Static Electricity to Science Learners

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Abstract

In many rural areas in South Africa, some deaths are thought to result from lightning which is associated with witchcraft, and some victims are accused of being behind lightning witchcraft. In such communities people believe that lightning can be sent through the practice of witchcraft to kill an enemy. This study investigated the effects of using the Dialogical Argumentation and Assessment for Learning as Instructional Model (DAAFLIM) in teaching static electricity focusing on lightning as an example of static electricity to grade 10 learners. Three classes of learners from two township schools served as the study's sample. A Solomon three-group design was employed in collecting data. One class was used as the experimental group and the other two were the control groups: control 1 group and control 2 group. The frameworks that were applied in the analysis of the data were Toulmin's Argumentation Pattern (TAP) and Ogunniyi's Contiguity Argumentation Theory (CAT). The results showed that the experimental group was more elaborate in their explanations of the scientific nature of lightning and achieved better academically than the control group which was not exposed to the DAAFLIM. It was also discovered that learners do not actually leave their traditional ideas at home while other learners come with some scientific conceptions about lightning. The study recommended that the DAAFLIM could be applied more effectively and efficiently if combined with technology. This would also help to include more sensory organs, and in that way provide better learning.

Keywords: argumentation; Dialogical Argumentation and Assessment for Learning as Instructional Model (DAAFLIM); electrostatics; lightning; performance

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Introduction

Science education is about helping learners to develop essential skills and attitudes, think in clear and logical ways, and solve practical problems. All these processes, skills, and attitudes are acquired through the medium of inquiry approach whereby learners are exposed to situations that stimulate their curiosity and interest to identify problems in their own environment and attempt to solve them (Erduran et al. 2004).

Despite decades of educational reform in our schools, it is apparent that not every learner is being adequately prepared for a future career in science (Ajani 2020; Makgatho and Mji 2006). The recurring poor academic performance of learners in science, therefore, calls for a concerted effort regarding measures that will improve the status quo. This study proposes a teaching-learning assessment model that will help learners improve their performance and results.

To make science more relevant to learners' socio-cultural environment, teachers have become aware of the need for professional development to meet the mandate of learner-centred instruction, such as problem solving, group work, projects, practical work, dialogical argumentation instruction, assessment for learning, concept mapping, and V-diagramming (Ersoy and Dibler 2014). Although there are many inquiry-based and learner-centred instructional approaches, this study adopted dialogical argumentation approaches and assessment for learning approaches as espoused by scholars such as Simon and Johnson (2008). According to Steyn (2008), the classroom practices of teachers need to be improved to support and improve learners' problem-solving skills in the classroom. Similarly, teachers need to be responsible for how they individually and collectively improve their classroom teaching to enhance their learners' performance (Department of Basic Education 2011).

The different curriculum reforms South Africa has embarked on have not really helped break the existing socio-economic inequalities. The various reforms (e.g., Curriculum 2005, the National Curriculum Statement [NCS], and the Curriculum Assessment Policy Statements [CAPS]) initiated by the South African government have proven to be a catastrophe and uninspiring considering that schools have remained spaces where inequalities, violence, vandalism, harassment, stratification, and various crimes continue to exist (Ngobeni et al. 2023).

There is consensus in the literature that, by engaging learners in classroom argumentation discourse alongside formative assessment, they can develop, think critically, and argue about issues related to science. As a consequence, they improve their understanding of scientific concepts as well as relate what they have learnt to their daily endeavours (Erduran et al. 2004; Hagop 2015; Ogunniyi 2007; Osborne 2014).

The aim of this study was to suggest the use of the Dialogical Argumentation-Assessment for Learning Instructional Model (DAAFLIM) to improve the academic performance of learners regarding static electricity.

Research Question

What is the difference in learners' academic performance regarding static electricity between those who were exposed to the DAAFLIM and those who were not exposed to the DAAFLIM?

Literature Review

According to Phillips (2023), one of the greatest challenges facing educators worldwide today is how to produce learners who are critical thinkers. Critical thinking can be fostered in the classroom by applying learner-centred instruction and assessment.

Learner Beliefs About Static Energy and Lightning

Moyo and Kizito (2014) found that African learners learning Western science and mathematics display certain traits that are not congruent with other learners. The number of learners who pursue professions that require more science and mathematics is far smaller in developing countries compared with learners who are from developed countries. Regmi and Fleming (2012) noticed that if the socio-cultural environment of learners is ignored, it becomes difficult for new learning to occur. For science education to be effective it must take much more explicit account of the cultural context of the society which provides its setting.

Jegede's (1995) paradigm highlights the relevance of constructivism, where learners construct their own knowledge from new experiences using existing conceptual frameworks and the world-view they bring to the science classroom. He further suggests that the concepts to be learned must begin from where the learner is and what they already know.

Dialogical Argumentation and its Benefits

In a dialogic classroom, teachers and learners act as champions where they collaboratively engage in generating and evaluating new interpretations of situations in order to gain a fuller appreciation of the world as well as themselves. Black (1998) is of the opinion that quality teaching involves providing quality feedback to learners to assist them with arguing from evidence to explanation. Argumentation is believed to feature prominently in real-life practices and can help learners to learn core content.

Educational researchers such as Alexander (2008) and Cazden (2001) have for many years criticised recitation as a prevalent instructional approach to conduct lessons as the teacher is regarded as the "only one who knows." These researchers also reckon that through recitation, teachers ask known information questions and therefore control the key aspects of communication. This is then believed to impede learner engagement and learning at higher levels of cognitive complexity. Hence, this study suggests that communication in the classroom needs to be more dialogic.

Argumentation plays an important role in the teaching and learning process. According to Chinn and Clark (2013), engagement in argumentation can result in educational benefits that include motivation, content learning, argumentation skills, and knowledge building practices. Researchers such as Andriessen (2006) and Schwarz (2009) have distinguished between learning to argue and arguing to learn. When learners engage in argumentation it is for the purpose of mastering content about which they are arguing. For example, when learners engage in argumentation about how to explain the results of experiments with electric circuits, they may learn something general about how to construct arguments and counter arguments and rebuttals, and they may also learn core ideas about electric circuits, such as Ohm’s law. Therefore, the focus is on content learning, learning the core concepts.

Asterhan and Schwarz (2007) also found that undergraduates who engaged in argumentation about evolution theory showed more gains in understanding the evolution theory principle than undergraduates who simply collaborated without encouragement in argumentation. Sampson and Clark (2009) investigated high school learners’ learning about melting through argumentation. Learners who engaged in argumentation demonstrated greater mastery of ideas about heat and temperature than learners who wrote arguments individually but did not engage in collaborative argumentation. Collaborative argumentation therefore appears to have benefits over and above individual argumentation.

Teaching science involves introducing learners to the science community’s ways of talking and thinking. In light of the above, it is believed that argumentation helps teachers to move from a situation where learners understand little or nothing about science concepts to one where they are able to talk and think about the concepts themselves. Therefore, argumentation is essential to understanding the nature of science. Newton et al. (2014) and Driver et al. (2000) have strongly expressed that argumentation is a critically important epistemic task and discourse process in science.

Argumentation is also seen as a reasoning strategy which falls under the general reasoning domains of informal logic and critical thinking (Salter and Renken 2017). There is increasing evidence in science education that argumentation is a powerful strategy for teaching and learning (Kuhn 2005). Through dialogical argumentation, the teacher is able to attend to the learners’ points of views as well as to the school science view (Diwu and Ogunniyi 2012).

Argumentation is central to this study as it helps learners to use their indigenous knowledge to understand the scientific explanation about certain concepts. Mavuru and Ramnarain (2020) showed that learners from different socio-cultural backgrounds experience school science differently. Dialogical argumentation as a teaching and learning method, therefore, facilitates the border crossing.

Assessment for Learning

McManus (2008, 3, cited in Ozan and Kincal 2018) defines assessment for learning as a process in which both teachers and learners offer feedback during instruction to structure the teaching and learning process, ultimately aiming to enhance learner performance. According to Wuest and Fisette (2012), formative assessments help teachers determine whether learners have grasped the material and provide valuable insights for planning future lessons.

Assessment in education is about gathering, interpreting, and using information about the processes and outcomes of learning. Assessment takes different forms and can be used in a variety of ways, such as to test and certify achievement in order to determine the appropriate route for learners to take through the differentiated curriculum or to identify specific areas of difficulty or strength for a given student. Assessment is an integral part of learning and is one of the most powerful educational tools for promoting effective learning. Black (1998) found that successful learning occurs when learners have ownership of their learning and when they understand their goals and are motivated to achieve success. Good assessment takes into account the learning styles, strengths, and needs of the learner.

Teachers should not be treated as the only source of feedback. Andrade et al. (2015) trust that self and peer assessments when taught carefully can guide learners to provide their own constructive and learning-oriented feedback. This process helps learners to criticise their own work according to clearly stated expectations which are provided as aims or objectives of lessons (Liu and Yu 2022). Assessment for learning is tiered at the top of the list in studies that compare teaching strategies, and techniques in terms of the degree of influence on learners' academic achievement. Related meta-analysis studies have also shown that assessment for learning has a high impact scope in terms of learner success. Findings by Xue and Bickel (2003) and Rodriguez et al. (2005) confirmed that the most significant discovery on the use of formative assessment is the increased improvement for low achieving learners.

Conceptual Framework for the Study

Figure 1 shows the conceptual framework for dialogical argumentation. It shows how the context-based science curriculum, constructivist learning theory, and assessment for learning are interrelated with the dialogical argumentation instruction method.

As illustrated in the figure, the context-based science curriculum enhances problem solving skills by linking science to cultural experiences. The constructive theory of learning emphasises the use of prior learning in constructing new learning and thereby improve cognitive structure. Assessment for learning is context-based assessment and focusses on learning process and self-assessment.

Figure 1: Conceptual framework for the DAAFLIM

The learners bring their own views on lightning and in class are taught the scientific perspectives of lightning through dialogical argumentation. According to Aikenhead (2002) and Ogunniyi (2005), this is with the intention of assimilating the learner into the scientific world-view. Once the learner is exposed to the scientific view, they are then left to choose between school science and their own cultural beliefs, customs, and practices about lightning. During the lessons, the teacher, using context-based curriculum, collaborative learning, and a cross-cultural pedagogical approach, teaches both conceptions from scientific and cultural perspectives. The aim of this exercise is to guide the learner to navigate between everyday conceptions of lightning and those presented through school science. Assessment for learning is thus being used as an encouragement for learners to engage in interactive assessment tasks because what transpires out of collaborative learning as per Sawyer (2004) and cross-cultural pedagogy cannot be predicted in advance. The study attempted to determine the effect of these interactions through the DAAFLIM on the learners' performance regarding static electricity.

Theoretical Framework

This study is grounded in a constructivist research paradigm as learner-centred instruction is framed within this learning paradigm. The theoretical framework for this study draws inspiration from a variety of theoretical paradigms about learning science. The most prominent theoretical frameworks used for this study were Toulmin's

Argumentation Pattern (TAP) and Ogunniyi's Contiguity Argumentation Theory (CAT).

Toulmin's Argumentation Pattern (TAP)

Toulmin (1958) developed a model of argumentation that has been used by educators and science educators to identify the components and complexities of learners' arguments. He describes the structure of an argument as comprising an interconnected set of claims, which are conclusions whose merits are still to be established. Data or grounds supports the claim, warrants provide a link between data and the claim. Backing strengthen the warrants and rebuttals which point to the circumstances under which the claim would not hold true.

According to TAP, the strength of an argument is based on the presence or absence of specific combinations of these structural components (Sampson and Clark 2008).

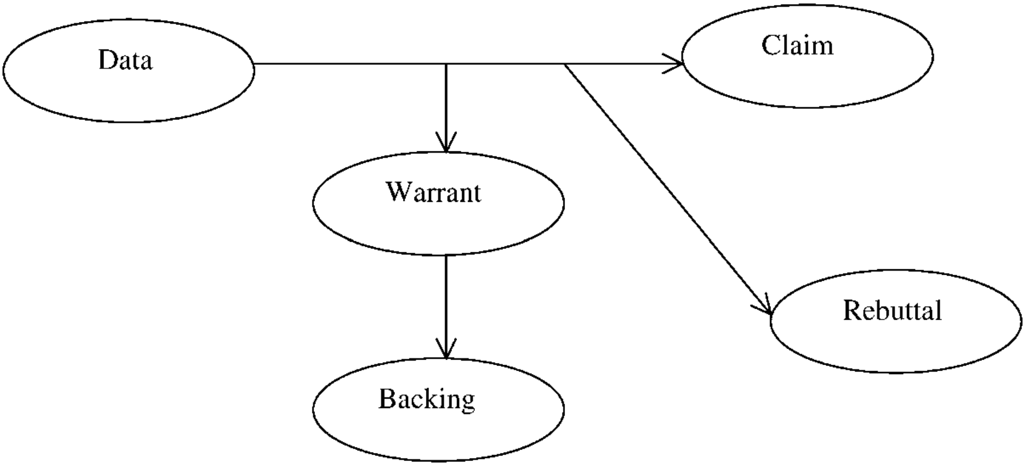

Figure 2: Toulmin's Argument Pattern (Toulmin 1958, cited in Erduran and Osborne 2004)

This study used TAP as a methodological tool for analysing oral argumentation. Research on pedagogic practices show that Toulmin-based materials are advantageous in helping teachers conceptualise argument and model it for learners.

The Contiguity Argumentation Theory (CAT)

The Contiguity Argumentation Theory (CAT) was used in addition to the TAP in the study as it deals with logical and scientifically valid arguments as well as non-logical metaphysical discourses embraced by Indigenous Knowledge Systems.

According to Ogunniyi and Hewson (2008), CAT asserts that the two different co-existing systems of thought, such as science and IKS, tend to readily link with each other in the mind of the learner to create a most favourable cognitive state. When a conflict arises in the mind of the learner, as a result of being exposed to science at school and IKS at home, an internal argument or conversation arises within the learner. According to Ogunniyi (2011), an internal dialogue or argument supervenes within the learner's working memory to resolve the conflict between the competing thought systems. The CAT also holds that claims and counterclaims on any subject matter within fields like science and IKS can only be justified if there is no system that is dominant over the other. That way, learners will be able to negotiate the meanings across the two distinct systems of thought so as to integrate them. The CAT was used in this study as a framework to analyse and explain how learners resolve conflicts arising between the scientific and indigenous views of the selected phenomena.

The theories discussed above are relevant to this study in that they highlight the value of cultural and social components of making sense of the natural world. These theories also suggest that teachers need to exploit and consider the ideas that learners bring to science classrooms from home.

Methodology

The study was conducted in two predominantly Black township high schools under the Metro East Region of the Western Cape Education Department (WCED) in Cape Town. The two schools involved in the study were from the same community and the learners' backgrounds were similar. A sample of 125 learners (78 girls and 47 boys between the ages of 15–18 years) was randomly selected from the two schools. Their performance was almost the same and their teachers had the same level of teaching qualifications and similar experience in teaching the physical sciences. Permission was obtained from the Western Cape Department of Education and the principals of the schools that participated in the study. Consent was obtained from the subjects themselves. Anonymity, self-determination, and confidentiality were ensured during the administration of the instruments.

A Solomon three-group design was used to collect data as three groups were used in the study. Two groups received pre-tests and one group did not. Table 1 illustrates an intervention plan on how students were divided into three groups with sample sizes (n): Experimental group (E), control 1 group (C1), and control 2 group (C2). E and C2 were treated with the DAAFLIM as an intervention and C1 was treated with the traditional teaching method. E and C1 wrote both pre-test and post-test. C2 wrote only the post-test.

Table 1: Intervention plan

Group	Pre-test	Intervention (DAAFLIM)	Post-test
E (n = 40)	X	X	X
C1 (n = 43)	X		X
C2 (n = 42)		X	X

Quantitative and qualitative research methods were used in the study. The instruments that were used were questionnaires, a science achievement test, open-ended interviews, and group observations. The reliability of the questionnaires was established by means of Cronbach's alpha coefficient using SPSS (version 26). The items were found to have an alpha value close to 0.72 for E and C1groups.

Results and Analysis

Learners' Performance in Static Electricity (Lightning)

Statistical techniques such as paired t-tests were applied with the help of SPSS version 26 and results were determined as per the level of significance, which was set at 5%. Paired-samples t-tests were conducted to compare scores on two different variables but for the same group of cases, while independent-samples t-tests were conducted to compare scores on the same variable but for two different groups of cases, and with equal variance assumed. Moreover, a test was conducted to see whether there was a significant difference in the performance of the experimental group before and after being exposed to the DAAFLIM. Similarly, a comparison of the performance of C1 before and after being exposed to the traditional teaching method was performed.

Learners' Performance: E vs C1 (Pre-Test)

The performance of learners from the two groups was compared using a paired t-test using the data collected from the science achievement test. This was done to see whether there was a statistically significant difference among the two groups in terms of their knowledge about static electricity at the start of the study.

Table 2: Statistical table of E_PRE and C1_PRE

Test	Group	N	Mean	SD	Mean Diff	t-critical value	t-ratio value	Remark
(It-test)	E_PRE	40	8.75	3.440	1.122	1.594	0.115	NS
	C1_PRE	40	7.63	2.968				

It-test: T-test; NS: Non-significant difference

The pre-test results in Table 2 show that the difference between the mean scores (8.75 and 7.63) and standard deviations (3.44 and 2.968) for the E and C1 groups, respectively, are small. The t-ratio value of 0.115 is less than the t-critical value of 1.594 at $p < 0.05$, which indicates that the null hypothesis, which expects no significant differences between mean scores of the groups, can be accepted.

Therefore, it can be concluded that there was no statistically significant difference between the two groups at the pre-test stage of the study, suggesting the comparability of the two groups before the two groups were exposed to or treated with the DAAFLIM or the traditional method of teaching. However, it can also be assumed that both groups did have some understanding of the selected concepts, because their average scores were 8.75 (E) and 7.63 (C1) on the pre-test.

Performance of Learners: E vs C1 (Post-Test)

Group E was exposed to the DAAFLIM whereas C1 was treated with the traditional chalk and talk teaching method. To see whether there was a difference in the performance of the learners from these two groups after being exposed to the DAAFLIM or traditional methods, a t-test was used. In Table 3 below, the mean score of E at a pre-test level was 15.03 (SD = 2.019). The mean score of C1 was 13.02 (SD = 3.227). The mean score of E was higher than the mean score of the C1 with a mean difference of 2.001.

Table 3: Statistical table of E_POST and C1_POST

Test	Group	N	Mean	SD	Mean Diff	t-critical value	t-ratio value	Remark
(It-test)	E_POST	40	15.03	2.019	2.001	3.347	0.001	Significant at 5%
	C1_POST	40	13.02	3.227				

The t-test result showed that there was a statistically significant difference in the score mean of the two groups at post-test level. This means that the learners in E performed better than those in C1. As discussed earlier, there was no statistically significant difference in the performance of Science Achievement Test (SAT) at the pre-test level. The difference in performance can mostly be attributed to the teaching method that was used in teaching these two groups. Therefore, it is evident that the DAAFLIM was more effective than the traditional teaching method in teaching static electricity (lightning).

Moreover, a further analysis showed that the standard deviation of E changed from 3.440 at pre-test to 2.019 at post-test level whereas the standard deviation of C1 changed from 2.968 to 3.227. The standard deviation showed how the individual learners' scores deviated from the mean score of their respective group. While the standard deviation of E decreased, the standard deviation of C1 increased. This shows that the DAAFLIM was more effective in bridging the gap between the learners' IKS views and science views. Therefore, it can be ascertained that the DAAFLIM not only provides a platform for learners to share their views but also construct new scientific learning using their prior knowledge.

As discussed earlier C1 and E were comparable at the pre- test. After being exposed to the DAAFLIM, E performed better than C1, which has been treated with the traditional method of teaching. The results showed that the performance of the learners who were exposed to the DAAFLIM were significantly better than those treated with the traditional teaching method. Some researchers have concluded that assessment for learning and argumentation methods significantly increase the academic achievement of learners by enabling them to participate in the lesson (Kingston and Nash 2011; Shepard 2000; Taras 2007; Wylie and Ciafalo 2010; Yeh 2009).

The Findings on Learners' Performance in Static Electricity (Lightning)

The DAAFLIM improved the learners' performance in the post-test in static electricity. It was evident from this study's findings that assessment for learning improved learners' attitudes toward learning because it focused primarily on helping them understand their learning levels. It also increased their desire for learning, boosted their confidence, and responsibility towards their learning. The findings of the study on the effect of the DAAFLIM supports the findings of Irons (2008) on assessment for learning.

The findings of the study showed that the academic achievements through the test scores of the learners in E where the DAAFLIM was applied were significantly higher than those in C1 where no intervention methods were applied.

Dialogical argumentation provided the learners with an opportunity to reflect on the two views—the science view and the IKS view—and enhance their critical thinking. The argumentation helped them to resolve some conflicting views they had. Regardless of the strength of the scientific explanation of lightning, some learners opted to hold on to their IKS beliefs (Stefanidou 2019). However, while holding on to their beliefs, their performance improved because they knew what was expected of them in school science through assessment for learning. Assessment for learning afforded learners an opportunity to evaluate their progress in terms of the learning goals and gave them a chance to realise what was expected of them in school science (Hattie 2023). It also guided them towards the learning goals and this in return enabled them to rectify their mistakes during the learning process.

One can therefore infer that the rudiments applied in assessment for learning practices, which include prioritising the learning and marking with comments instead of scores, teaching using group work which necessitates sharing and cooperation instead of individual efforts, and assessing learners in accordance with individual development levels, helped the learners to develop positive attitudes towards science.

The arguments of the learners from the activities in E and C1 were classified using Toulmin's Argumentation Pattern (TAP). A few statements made by the learners in both groups fell on the level 1 classification. These are the arguments that only had a claim but there was no evidence given to back up the claims made. The claims made also had no grounds or rebuttals. When discussing the causes of lightning, a learner in C1 said that lightning was caused by God when he is angry. The learner's statement can be categorised as level 1 argumentation, as level 1 argumentation consists of arguments that are a simple claim versus a counter-claim or a claim versus a claim. Some level 1 arguments came from learners who also said that lightning is caused by witches but had no data to back their claims and just said it was what they believed.

When asked about the cause of lightning in the activity, a learner from E claimed that lightning is caused by witchdoctors. When there were rebuttals challenging his claim saying that lightning is caused by God, his warrant was that when a boy in his village stole a witchdoctor's property, the witchdoctor told him that he would strike him with lightning and the boy was struck by lightning the next day.

Although there is confirmation that the DAAFLIM practices (e.g., group discussions, self-evaluation, teacher review) had a significant impact on learners' performance, there is still a need for further research. Even though there have been studies on the effect of assessment for learning and dialogical argumentation as instructional methods, there are very few studies that combine the two methods in one lesson. Numerous studies have also shown that dialogical argumentation and assessment for learning procedures have a stronger impact on underperforming learners. The studies show reasonably stronger improvements from learners who were previously underperforming. Additional research in this area may provide suggestions for teachers who have very large numbers of underperforming learners in their classes.

The Dialogical Argumentation and Assessment for Learning as Instructional Model (DAAFLIM)

Studies (Darmawansah 2024; Rapanta 2022; Hlazo 2021) that have been done on the Dialogical Argumentation Instructional Method (DAIM) showed that the method does not extrinsically include assessment strategies. The shortcomings of the DAIM led to the formation of the DAAFLIM. This model was developed by doctoral students at the Science Indigenous Knowledge Systems Project (SIKSP) group at the University of the Western Cape in South Africa, who had done their masters research using the DAIM.

The DAAFLIM places emphasis on and addresses the disconnect between the ways of assessing during the different stages of a DAIM lesson. This is done by using Assessment for Learning (AFL) strategies as stimulated by the work of Black and William (2009). The DAAFLIM provides the critical formative feedback to make sure that the objective of the learning activity is met during each DAIM process.

The DAAFLIM consists of six stages of cyclic swirls arranged in increasing sizes of a shell. All the swirls start at the nodal point. The symbolic representation of the cyclic swirls in the model provides space for a return to any stage of the discussions and arguments if required. In the DAAFLIM, the AFL-strategies are incorporated into the DAIM process as shown in the figure below.

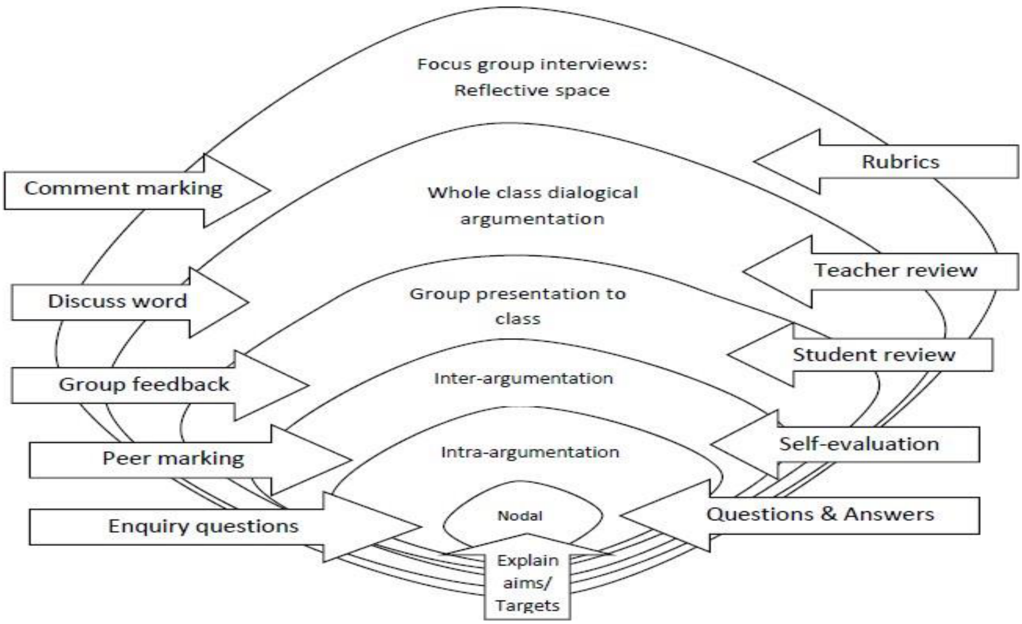

Figure 3: The DAAFLIM (adapted from George et al. 2019)

The six distinct stages of DAAFLIM are discussed below. During each stage the teacher employs an AFL strategy to track the performance assessment at that point of the DAIM. The nodal point is where the topic of the activity is presented.

Stage 1: DAIM—Nodal point: Introduction of the topic of discussion or activity.

AFL strategy—Learners use the KWL chart to state what they Know, what they Want to Know and what they have Learned. The teacher makes the aims of the lesson clear to the learners.

Stage 2: DAIM—Individual task (intra-argumentation)—Allows for individual thinking space.

Each learner is provided with stimulus material, then the learner is prompted to engage with the material through a set of questions. These questions promote internal argumentation (intra-argumentation). An accessible writing frame is provided to the learner to record claims, backings, warrants and rebuttals.

AFL strategy—Self-evaluation and enquiry questions.

Stage 3: Small group discussion (inter-argumentation)—Allows for individual sharing space with other members of the group (inter-argumentation). Each learner is invited to present his or her ideas, thus encouraging each group member's voice to be heard. After the group debate, an internal consensus (cognitive harmonization) is achieved for presentation to the class.

AFL strategy—Peer marking and group feedback.

Stage 4: Small group presentation—Allows for general discussion space. The group leader presents the arguments, counterclaims, rebuttals, evidence and warrants.

AFL strategy – Learner review and words discuss.

Stage 5: Whole class mediation—Allows also for general discussion space. This process is managed by the facilitator (teacher), who assists in identifying trends and patterns by advancing a cognitive harmonization.

AFL strategy—Teacher review.

Stage 6: Focus group evaluation—Allows for a reflective space. An interview process, managed by the facilitator, is held with a random selection of learners, in order to reflect on the process of argumentation and the understanding of the issue (George et al. 2019; Hlazo 2021).

AFL strategy—Comment marking. Dialogue between the teacher and individual learner to reflect on the lesson gives the learner an opportunity to express their ideas (Black and William 2009).

At the end of the activity, the teacher summarises the different groups' findings, highlights the misconceptions and erroneous concepts, and reinforces the intended learning objectives. Formative feedback is important to make sure that the objective of the learning activity is met at the end of the lesson (Swaffield 2011).

Conclusion

The findings of the study showed that the learners who were exposed to the DAAFLIM developed more scientific conceptions of lightning than learners who were not exposed to it. Most of the cultural beliefs do not have explanations and such beliefs are not meant to be questioned in a traditional society. The DAAFLIM provided learners with a platform to express their views and reflect on them. Such a platform helped them to see the relevance of science in real life and thereby develop a positive attitude towards science. This in turn allowed them to apply reason to their own beliefs, compare their beliefs with the scientific explanations, and rectify the misconceptions.

The DAAFLIM helped learners to use argumentation to engage with data and evidence, to make claims based on these, and to weigh the extent to which others' claims can be substantiated. The use of the DAAFLIM also created a positive learning environment that enabled learners to participate actively in class and led to the attainment of cognitive optimum. If learners are not given the chance to talk to one another and debate their ideas, it makes it difficult for them to learn science concepts. Therefore, the DAAFLIM can be deemed essential to understanding the nature of science.

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