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ORIGINAL ARTICLE

Enhancing Formal Assessment using Concept Cartoons in Physics: A Teacher's Perspective

William Zivanayi[1]*, Chinelo Georgina Candy Nwaigwe[2]

[1]Department of Secondary School Education, Faculty of Education, Mandela University, Gqeberha, South Africa, [2]Department of Secondary School Education, Faculty of Education, Nelson, Mandela University, Gqeberha, South Africa.

***Corresponding Author:** William.zivanayi@mandela.ac.za

ABSTRACT

Fostering methods that promote learners' conceptual understanding is crucial for better performance in science subjects. This study investigated how teachers of physical sciences perceive the utilization of Concept Cartoons as a formative evaluation tool. Ten Grade 11 teachers selected from secondary schools in the Nelson Mandela Bay district of Gqeberha were utilized for this study. A qualitative research approach which included a pre-intervention questionnaire, an intervention, and a post-intervention face-to-face interview was utilized. The intervention involved a discussion on how to use Concept Cartoons in formal assessment in the teaching of Newton's Laws. Pre-intervention phase results indicated that teachers were not using formal assessment techniques in their science lessons. Post-intervention results showed that teachers appreciated the use of Concept Cartoons as a formal assessment tool that could be used to improve conceptual understanding of Newton's Laws. The study concludes that Concept Cartoons have been effective as a science teaching tool. The use of Concept Cartoons provides an alternative formative assessment technique vital for the understanding of science concepts.

KEY WORDS: Concept cartoons; formative assessment; Newton's laws; pre-and post-intervention; qualitative study; summative assessment

INTRODUCTION

Most of our schools in South Africa are becoming more audio-visual when teaching science due to the poor availability of resources to do practical activities to enhance understanding of science concepts (Kurwa, 2016). The audio-visual teaching approach often requires the teachers and learners to talk as they express verbally their understanding of the concepts and often the classroom activities include conversations (Abdulrahman et al., 2020). Very often the success or failure of an audio-visual lesson depends on the classroom atmosphere and the pedagogical materials presented to the learners (Abdulrahman et al., 2020). In this relation, various audio-visual programs have the potential to be utilized as sources of authentic teaching techniques to provide an understanding of concepts. Authentic sources include television broadcasts such as news, movies, songs, cartoons, recorded conversations, meetings, and newspapers (Kabapınar, 2005; Kumar et al., 2021).

LITERATURE REVIEW

Concept Cartoons

For a very long time, cartoons have been widely employed as educational tools to improve and ease the process of learning. Regarding the constructivist method, Concept Cartoons function as teaching/learning tools for formal assessment since they elicit questions about learners' concepts (Oudah, 2021) and provide discussion and inquiry of ideas in learning (Kumi-Manu, 2021). Babari et al., (2023) posit that in the constructivist perspective, tools for probing students' ideas are equally great teaching/learning tactics for formal assessment. In this context, "Concept Cartoon" refers to a teaching strategy that aids formal assessment whereby learners are encouraged to present, discuss, and test their concepts.

Concept cartoons ease the workload for teachers by engrossing students in dull subjects. Cartoons breathe life into the subject's undiscovered mysteries and the lifeless pages of books (Kumi-Manu, 2021). When you open a page with a cartoon made on it, the cartoon will be the first thing you see, and you will attempt to understand the idea cartoon picture before reading the text (Bahadirovna, 2021). The Concept of Cartoon images seen by the learners leaves a lasting impression in their minds (Bahadirovna, 2021). They tend to remember what they saw in the form of Concept Cartoons, or what actions were performed by the cartoons or anything else.

Concept Cartoons lead to better understanding: Many topics cannot be theoretically understood. They need practical experiences or real-life examples. Concept Cartoons can help a lot in this situation (Kumi-Manu, 2021). The concept of cartoons can be easily used to narrate a story. With the use of concept cartoon characters and callouts, a story can be created easily to allow learners to understand burdensome concepts very comfortably (Kabapınar, 2005). Therefore, Concept Cartoons present important incidents that may describe a

concept that is beyond theoretical understanding. This implies that Concept Cartoons are superior to the presentation of facts on the board or paper - A story from Concept Cartoons may aid the learner in concentrating leading to better comprehension.

Cartoons are quite affordable when compared to other instruments such as projectors, computers, and other forms of smart technology (Yilmaz, 2020). If it is an animated video or movie, it only needs to be shown on a television screen; otherwise, it needs to be printed on a sheet of paper for comic strips. It is easy to find cartoons (Borzekowski, 2018). Comic strips can be extracted from newspapers or periodicals, or they can be obtained from the internet. It is assumed (Pekel, 2019) that Concept Cartoons improve cognitive abilities.

There is a danger associated with using humor in the classroom, and educators should be aware of any unforeseen repercussions when using humor, especially when it comes to verbal humor. Humor's inherent nature might make it appear unethical in comparison to the seriousness and even solemnity that define education (Labbé et al., 2022). Verbal humor experience indicates that delivery is a true ability, that not all students will pay attention and comprehend, and that there is a chance of offending due to misunderstandings since jokes might be seen as sarcastic, racist, or sexist. These are the reasons why Concept Cartoons are a superior substitute. The visuals and the message it conveys are both humorous.

Contextualization of the Study

A South African teacher must teach both Chemistry and Physics subjects in the Physical Sciences curriculum. This includes mechanics, waves, sound and light, electricity, and magnetism, organic and inorganic chemistry, physical chemistry, electrochemistry, acids, and bases (Mpungose, 2021). Many of these teachers are not fully conversant with both subjects (Physics and Chemistry) which comprises the learners' conceptual understanding of certain topics (Basson and Kriek, 2012; Mpungose, 2021). Newton's Laws are one of the topics in which learners struggle to grasp the concepts (Erfan and Ratu, 2018).

In the South African curriculum, Newton's laws are introduced as early as the tenth grade. Most learners can probably write out the formula, F = ma, and recite the laws word for word. However, the capacity to comprehend their meaning and accept their implications rather than being able to memorize the first law or use the second law to solve issues is the more important skill. While most learners are aware of Newton's laws, they are also unaware of their misconceptions (Aksit and Wiebe, 2020).

Overcoming misconceptions entails recognizing the misunderstandings, considering counterarguments or explanations, assessing the two conflicting concepts personally, and embracing a new notion that is more rational than the one that was previously believed (Soeharto et al., 2019; Sundaygara et al., 2021). This process involves critical thinking (evaluating two competing theories for reasonableness), assessment (choosing the most harmonious and reasonable model to explain the world of motion), self-reflection (considering your belief systems) Kurniawan (2018) self-examination, analysis, and assessment (Huda et al., 2022; Sundaygara et al., 2021). Using Concept Cartoons can help to overcome the misconceptions learners hold about Newton's Laws.

Concept Cartoons assist learners in challenging their ideas, finding solutions to problems they face in their daily lives, expanding their views, and seeing the situation from several angles (Yilmaz, 2020). Cartoon teaching was successful in generating concentrated conversations where learners' assumptions could be dissected, particularly when teachers posed challenging questions (Jamal et al., 2019). Using cartoon concepts to teach debate skills, Naylor and Keogh, (2017), make learning enjoyable Namrata (2021), students' attitudes and interests (Kaptan and Izgi, 2014), and student accomplishments Attard and Cremona, (2022) have been the subject of several previous research. Students' critical thinking abilities have significantly benefited from the successful use of cartoon ideas in anatomy learning, per the research of Bahadirovna, (2021). The study by Yilmaz, (2020) which claims that the idea of a cartoon has a major influence on critical thinking and student learning accomplishment, also corroborated the findings of the investigation. There is a paucity of research addressing instructors' opinions about the use of Concept Cartoons as an assessment tool in Newton's Laws, although numerous studies are connected to problem-based learning and cartoon ideas. This study explored the use of Concept Cartoons as a formative assessment tool in the teaching of Newton's Laws.

Statement of the Problem

Although formative assessment procedures are vital for improving conceptual understanding, South African teachers find it difficult to incorporate them into their lessons (Dliwayo, 2019; Labuschagne et al., 2023). High-stakes summative assessments, such as examinations and controlled tests, continue to be a major component of the South African educational system because these assessments weigh a lot toward the final mark of the learner at the end of the learning course. This problem has also been exacerbated by the Curriculum Assessment Policy Statement (CAPS), which encourages continuous (high-stakes) assessment and is comparatively content-heavy (Gölogluu Demir and Kaplan Keles, 2021). It may be inferred from the Physical Science CAPS document that South African teachers are not well-versed in formative assessment and do not have the tools necessary to convert from summative to formative assessment methods. This presumption suggests that the ordinary teacher is still eschewing the acquisition of skills and tools necessary to undertake a successful formative assessment in the classroom. Concept cartoons might be one way to close this gap.

Aim of the Study

This study explored Physical science teachers' perceptions of formative assessment and the usefulness of Concept Cartoons as a formative assessment instrument to assist teachers in their

practice of formative assessment. Therefore, the main study question of the study was:

> "What are Physical Sciences teachers' perceptions of the usefulness of Concept Cartoons as a formative assessment instrument in the teaching of Physics?"

The following sub-questions directed the investigation:

(i) How do teachers first perceive formative assessment?
(ii) How did the teachers perceive formative assessment after employing Concept Cartoons to encourage formative evaluation in teaching Newton's Laws?
(iii) What insights do educators have following using Concept Cartoons for formative assessment in their classrooms?

Theoretical Framework

This study is embedded within the social constructivism framework. According to Labuschagne et al. (2023), the social constructivist approach sees learning as an active process of knowledge construction in which students create meaning by fusing new concepts with what they already know. Social constructivism, according to Kar (2019) and Waite-Stupiansky (2022), assumes that people create meanings in addition to quickly comprehending and using information that is presented to them. It is recognized that people learn by assimilating—or fitting—new knowledge to what they already know. Due to this learning construction and process, Lloyd (2018) described individual learners as active participants in their intellectual development. Consequently, learning is a social activity that necessitates discussion with others; this type of discourse is most effective when it is relevant to the learner's prior knowledge and gaps (Sebastián et al., 2021).

Just as with the social constructivist approach, Concept Cartoons enables the teacher to work as a facilitator and a guide, whose role is to provide learners with opportunities and incentives to build knowledge (Naylor and Keogh, 2017). To put constructivist theory into reality in science classrooms, educators must provide students the chance to explore, argue, and discuss their ideas to generate concepts that are more widely accepted in science. Constructivism helps teachers grow and improve their teaching knowledge and abilities while also helping students grasp topics. The use of Concept Cartoons in instruction is most appropriate for higher-order thinking skills and problem-based analyses (Balim et al., 2016).

THE RESEARCH METHOD

This study's methodology and research strategy are based on a qualitative case study under the Social Constructivist paradigm. The study included qualitative techniques, including semi-structured interviews and post-implementation written comments from the participants. The purpose of this study was to produce a detailed account of a group of instructors' perspectives in a social and natural environment. The research questions posed in this study were approached using qualitative measures as they were broad, and general and required detailed descriptions of participants' experiences. A case study method was employed to get intimate, comprehensive, and in-depth analyses and explanations of a subject of study, with an emphasis on a modern occurrence, in, in this case, (Creswell and Poth, 2016; Yin, 2018) – the use of Concept Cartoons in formative assessment in Newton's Laws teaching within some real-life context was utilized.

The research design for the study is summarized below.

This qualitative case study was diagnostic and strategic, in the sense that the perceptions and understanding of the use of Concept Cartoons in the teaching of physics were probed, and then further developed through an intervention in the form of workshops as indicated in Figure 1. The intervention phase included the involvement of participants, discussing how the concept cartoon provided (Figure 2) can be used to teach conceptual understanding of Newton's laws at grade 11. The eight participants were then allowed to teach Newton's laws using concept cartoons. The final phase - the post-intervention phase was the participants' feedback, and this included an interview to determine if the attitudes and understanding of Concept Cartoons in teaching Newton's Laws were appreciated by the teachers (participants). Participants' post-implementation comments and pre- and post-semi-structured interviews were utilized to get deeper data, providing flexibility to further investigate responses and unexpected viewpoints.

Sampling

Since the study only included physical science instructors from six high schools in Gqeberha Central, South Africa, a purposeful sample approach was used. Teachers were invited to participate in this study based on their availability and desire to do so. Eight physical science teachers who were teaching grade 11 students in the physics component of the Physical science curriculum made up the sample. To qualify to participate in the study, the participant must have trained as a teacher and qualified with a Bachelor of Education degree or a Certificate of Education and had at <3 years of experience in teaching Physical science.

Data Collection Instrument

Documents, interviews, direct or participant observation, physical artifacts, and audio-visual materials are among the tools and data-gathering techniques advised for case studies (Creswell and Poth, 2016; Yin, 2018). When gathering data from the above-listed sources, qualitative researchers often use three primary techniques: participant observations, interviews, and document or records reviews (Creswell and Poth, 2016). Data for this study were gathered using semi-structured, open-ended questionnaires; semi-structured interviews; and written comments from participants after the implementation as summarised in Table 1. When teaching Newton's Laws, concept cartoons were utilized as a formative evaluation intervention.

Workshops on using concept cartoons to teach concept cartoons made up the intervention itself. Following implementation, semi-structured in-person interviews were carried out to find out how participating teachers used Concept Cartoons

as a teaching tool in their different classes and to get their opinions on the overall process. The participants kept reflective notebooks in which they documented their experiences during the whole process. An example of the concept cartoon used in the intervention stage is in Figure 3.

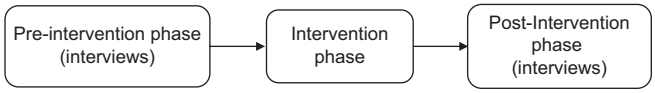

Figure 1: Diagrammatic representation of the research design

Data Analysis

Comparing participants' perspectives before and after the intervention was the analytical approach. The purpose of this method and comparison was to determine how the participants interpreted the questions from the questionnaire and the interview (Creswell and Poth, 2016). The last interpretative task was summarizing the case study's results

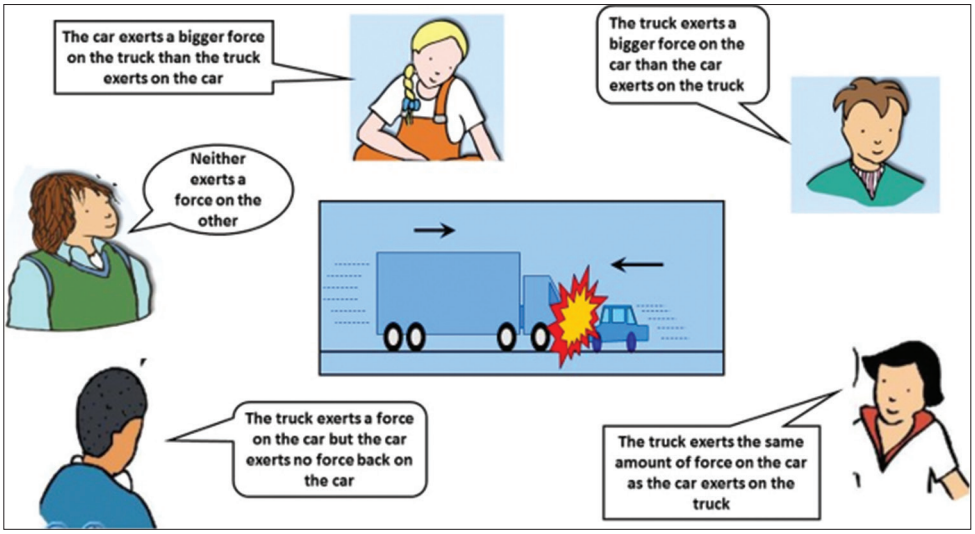

Figure 2: An example of the concept cartoon used at the intervention phase. Adapted from Naylor and Keogh (2017)

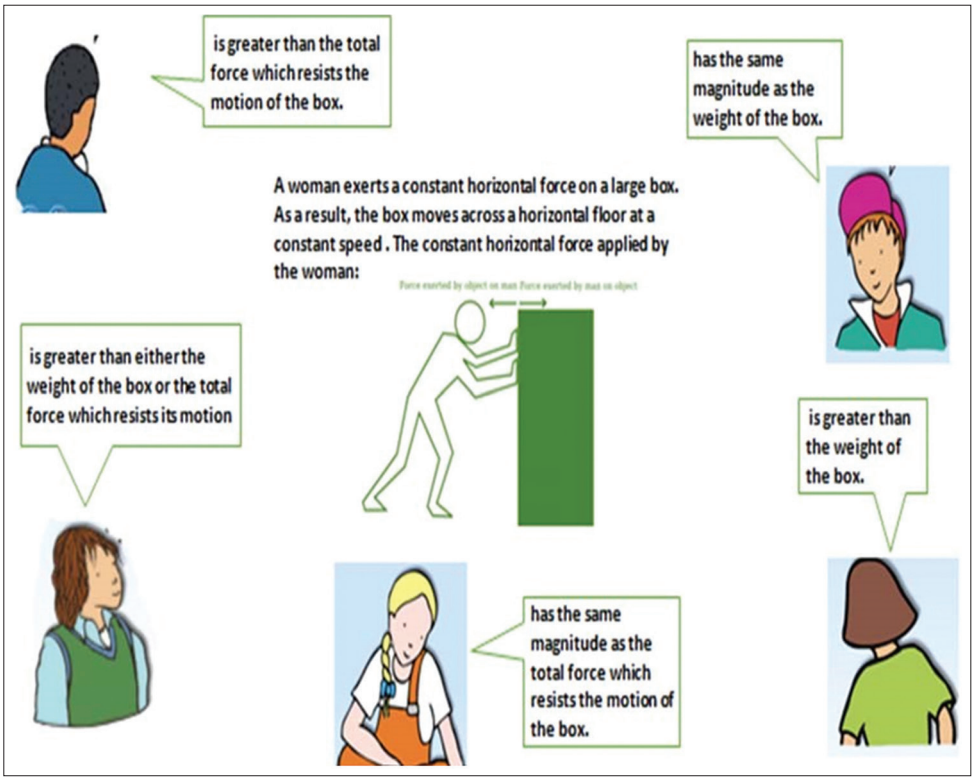

Figure 3: A sample of concept cartoon used at implementation. Adapted from Naylor and Keogh (2017)

Table 1: Summary of the data collection methods used in the study

Criteria	Pre-intervention	Post-intervention	Post-implementation
Expectation	Initial perceptions of teachers on the use of Concept Cartoons in the teaching of Newton's Laws	Perceptions of teachers after the workshop on the use of Concept Cartoons in teaching of Newton's Laws	Perceptions of teachers after implementation i.e., the use of Concept Cartoons in the teaching of Newton's Laws
Research question	How do teachers first perceive formative assessment?	How did the teachers perceive formative assessment after employing Concept Cartoons to encourage formative evaluation in teaching Newton's Laws?	What insights do educators have following using Concept Cartoons for formative assessment in their classrooms?
Instrument	Open-ended questionnaire	Open-ended questionnaire	Written reflections

in detail and evaluating Concept Cartoons' suitability for formative assessment teacher preparation. An interview approach was also used to get more information and to confirm the correctness of the questionnaire replies. To check for consistency, the interview replies of each participant were compared to those on their questionnaire.

Ethical Considerations

Before the research started, Nelson Mandela University provided ethical approval. It was requested and granted permission from the appropriate gatekeepers, which included the principals of the chosen schools and the Port Elizabeth District's Department of Basic Education. Before any data were collected from the participants, they were fully informed about the purpose of the study, and their consent was obtained.

FINDINGS

Pre-interventions Phase

An open-ended questionnaire was used to collect the demographic data of the participants and sought to address the first research sub-question:

What are teachers' initial perceptions of formative assessment?

The demographic data of the participants is given in Table 2.

Table 2: The demographic data of the participants

Teacher identifier	Teacher qualification	Teaching experience
TI 1	Bachelor of Science Engineering and PGCE	8
TI 2	Bachelor of Science (Honors) in Biochemistry, and PGCE	20
TI 3	Diploma in Education, Bachelor of Science in Chemistry	10
TI 4	Diploma in Education, Bachelor of Science in Computer Science	16
TI 5	Diploma in Education, Bachelor of Science (Honors) in Physics	10
TI 6	Bachelor of Science in Physics, PGCE	15
TI 7	Bachelor of Education - Physical Sciences	12
TI 8	Bachelor of Education - Physical Sciences	5

The participants' initial definitions of formative assessment

Participants were asked to write down their ideas, thoughts, or feelings regarding formative assessment on the pre-intervention questionnaire. The definitions of formative evaluation provided by each participant are listed in Table 3.

Table 3: Participants initial definitions of formative assessment

Participant	Participants' initial definition of formal assessment
TI 1	*"Variety of methods used by teachers to conduct an in-process evaluation of learner comprehension, learning needs, and academic progress during a lesson. It is a beneficial tool that teachers cannot do without"*
TI 2	*"Assessment is given to learners to elicit responses at the end of each activity or lesson. It is an effective form of assessment as it allows learners to evaluate their progress in the learning environment"*
TI 3	*"Methods that a teacher may employ to evaluate the learning progress of the learners during a lesson. This gives insight to the teacher as to whether the learning process is successful or not"*
TI 4	*"An assessment that helps learners learn and develop"*
TI 5	*"A good method of assessment that can be fun for learners"*
TI 6	*"Methods teachers use to evaluate learners"*
TI 7	*"An assessment to evaluate what the learners know/learned after a given lesson or in the process of it"*
TI 8	*"A variety of methods that some teachers use to conduct evaluations of learner understanding of concepts. It is a very good form of assessment as it allows for assessment of learners with diverse capabilities"*

The participants referred to the need for a range of techniques in formative assessment to elicit answers from students. These participants are aware that formative evaluation needs to be a component of education, as evidenced by their usage of phrases like 'during a lesson." This is also consistent with the idea that instruction and formative evaluation are linked. When a teacher presents something, they evaluate the student's response to it. The instructor modifies the curriculum and assists with comprehension.

A teacher can determine the effectiveness of the lesson through formative assessment. TI 3 was asked what he would have done if he had learned that his learners had not understood a lesson to get clarification on the meanings the participants assigned to formative assessment. TI 3 responded, "*I will have to reteach the content of that lesson using a different teaching method.*" This agrees with Kim (2019)'s view that formative assessment insights should be used immediately as part of the instructional process to adjust instruction to form new learning.

"Formative assessment enables learners to think about their learning," states TI 5. According to TI 2, "It allows learners to evaluate their progress in the learning environment," in a similar manner. It makes pedagogical sense for students to take responsibility for, or at the very least be closely involved in, all significant choices that have an impact on their education, as they are the center of their learning. According to Kim (2019), the most significant determinant of success is the choices made by the learners themselves, particularly those made during and after formative assessment.

Tools and frequency of engagement

From the responses of the participants to items on the pre-intervention questionnaire, it was deduced that the participants had limited knowledge of the tools with which to implement formative assessment. Tables 4 and 5 are a summary of the participant responses based on the tools and their frequency of engagement in formative assessment before the intervention.

Table 4 demonstrates that all the participants employed tests as a tool for formative evaluation. Just one person (TI 7) selected more than two instruments; however, four out of the eight individuals (50%) selected one more instrument. Only one participant selected "other," even though the participants were free to mention any other instruments they used that were not on the researcher's list.

Table 5 demonstrates that 50% evaluated their students often. One person (12.5%) assessed seldom, whereas three individuals (37.5%) assessed infrequently. The individuals who relied only on examinations as their primary means of assessment were the ones who underwent frequent evaluations. Most individuals who coupled playing games with creating models were the ones who were evaluated infrequently and infrequently.

The pre-intervention questionnaire's analysis and discussion showed that the participants lacked techniques for putting formative assessment into practice, had little experience with legitimate formative assessment tools, and had little awareness of formative assessment itself as indicated in Table 6. Following the implementation of formative evaluation utilizing Concept Cartoons, the participants further attested to this fact in the interviews.

The Participants' Post-intervention Perceptions of the Use of Concept Cartoons for Formative Assessment

The post-intervention questionnaire sought to address the second research sub-question:

> *How did the teachers perceive formative assessment after employing Concept Cartoons to encourage formative evaluation in teaching Newton's Laws?*

The study sub-question served as the inspiration for the questionnaire items, which were designed to get participants' opinions on formative evaluation following the intervention. Themes and sub-themes are identified because of the data acquired throughout this procedure, and they are covered in the next section. The initial question on the post-intervention survey asked participants to explain how they conducted formative evaluation following the session. The participants' formative assessment is described in Table 7.

However, following the session, the participants' definitions seemed more realistic and included certain formative assessment elements that were absent from their initial definitions. This was taken to indicate that the participants had a greater comprehension and awareness of formative evaluation.

Concept cartoons as formative assessment instrument for teachers

One of the items of the post-intervention questionnaire asked the participants, "How do you feel about using Concept Cartoons as a formative assessment tool in your teaching?" In Table 9, the participants' perceptions of Concept Cartoons as a formative assessment instrument post-workshop are presented.

All the participants shared the opinion that Concept Cartoons are a very helpful tool that can be used to execute formative

Table 4: Instruments of engagement

Tools/ Instruments	Participants							
	TI 1	TI 2	TI 3	TI 4	TI 5	TI 6	TI 7	TI 8
Test	✓	✓	✓	✓	✓	✓	✓	✓
Drawings	✓						✓	✓
Concept mapping								
Game playing					✓		✓	
Model-making							✓	
Others				✓				

'✓' is a symbol to indicate the instruments the participants used for assessment. Others: Any other tool besides those highlighted in the table

Table 5: Frequency of Engagement

Frequency	Participants							
	TI 1	TI 2	TI 3	TI 4	TI 5	TI 6	TI 7	TI 8
Very often								
Often	✓	✓				✓	✓	
Not so often			✓	✓				✓
Rarely					✓			

Very often=all lessons; often=most lessons but not all; not so often=once in a week; rarely=fortnightly or termly. '✓' is a symbol to indicate how often the participant assessed the learners

Table 6: Summary table of emerging themes from part one

Research sub-question	Strategy	Emerging points from pre-intervention phase
How do teachers perceive formative assessment?	Open-ended pre-intervention questionnaire	• Insufficient familiarity with real formative assessment tools. • Insufficient understanding of formative assessment; and • Absence of implementation techniques

evaluation, even before they had the opportunity to utilize the cartoons effectively in their lessons. Concept Cartoons relieved the participants of the fatigue and time-consuming nature that accompany repeated testing, marking, recording marks, and reteaching. This may be the case because, while the students are debating the concepts the cartoon characters are presenting, teachers may utilize concept cartoons to spot and address any alternate conceptions or learning requirements of the students. Concept Cartoons are a simple way to do formative assessment since they may lessen the difficulty of putting formative assessment into practice, as stated by TI 1. "Ease the hurdle" implies that, in contrast to participants' customary tiresome testing cycle, Concept Cartoons makes formative evaluation less difficult and more straightforward.

Table 7: The Participants' post-intervention definition of formative assessment

Participant	Participant post-intervention definition of formative assessment
TI 1	*"It forms a very essential part of teaching and learning"*
TI 2	*"A progressive, ongoing process that assesses the progress of learners in a learning curriculum"*
TI 3	*"Ways of checking the progress of a lesson during the teaching period"*
TI 4	*"A very objective assessment that helps to assess how learners are taking in content"*
TI 5	*"A very useful tool to ensure learning and assessment runs concurrently"*
TI 6	*"An assessment that assists learners to learn and understand better"*
TI 7	*"Variety of methods that teachers use to check learners' understanding"*

Table 8: Perception of concept cartoons as a formative assessment instrument post-workshop

Participant	Perceptions of concept cartoons as a formative assessment instrument post-workshop
TI 1	*"Concept Cartoon is an easy means of conducting formative assessment because it can help ease the hurdle involved in the implementation of formative assessment"*
TI 2	*"Concept Cartoon can help learners develop interest in the lesson. It helps to develop learners understanding of basic concepts taught in the class"*
TI 3	*"It is very helpful but should also be used together with other methods"*
TI 4	*"Concept Cartoons are very helpful because they can help learners form a picture in their heads to understand the concepts"*
TI 5	*"Concept Cartoon is a very useful tool for formative assessment"*
TI 6	*They are very useful and can be used to make teaching easier in addressing and explaining concepts"*
TI 7	*"It is a very good form of assessment, especially as the Concept Cartoons will help each learner understand the concepts"*

Confidence to implement formative assessment

The participants were asked to score their confidence in using formative assessment in their classroom on a scale of 1–10 on the post-intervention questionnaire. In addition, the participants were asked to justify their responses. The participants' understanding of formative assessment was enhanced by the intervention, and this in turn gave them more confidence to use formative assessment in their instruction. After utilizing the Concept Cartoons throughout the workshop, the participants realized how helpful they might be for the students and how they could help the teachers perform formative assessments.

According to Table 9, the participants gave a positive rating of confidence that ranged from 6 (very confident) to 10 (very confident). The increase in confidence appears to have been caused by the intervention, according to an analysis of the factors that led to the indicated confidence levels.

The intervention improved the participants' formative assessment knowledge, which, in turn, increased their confidence to implement formative assessment in their teaching. The participants, after using the Concept Cartoons during the workshop, could see that Concept Cartoons might be beneficial to the learners and assist the teachers in implementing formative assessment.

As a good summation of the participants' thoughts in this regard, participant TI 1 wrote:

> *"Through the workshop and interactions, I learned a lot about formative assessment and how Concept Cartoon*

Table 9: The participants' confidence levels to implement formative assessment

Participants	Rating	Interpretation	Participant's reasons for confidence level
TI 1	7	Very confident	*"Through the workshop and interactions, I learned a lot about formative assessment and how Concept Cartoon can help ease the hurdle involved in the implementation of formative assessment".*
TI 2	8	Very confident	*"I have developed more skills in using and designing Concept Cartoons to teach basic concepts in Physical Science".*
TI 3	8	Very confident	*"I have learned how to use Concept Cartoon in formative assessment".*
TI 4	10	Extremely confident	*"It will help the learners to participate and also to relate with the concepts taught".*
TI 5	6	Confident	*"It's something I have not been used to using but it is very useful, and I've learned to use it".*
TI 6	8	Very confident	*"I learned a lot from the workshop on how to use Concept Cartoons to implement formative assessment".*
TI 7	8	Very confident	*"…because I learned to use the Concept Cartoons during the workshop".*

Table 10: Summary of emerging themes from part two

Research sub-question	Strategy	Emerging points from pre-intervention phase
How did the teachers perceive formative assessment after employing Concept Cartoons to encourage formative evaluation in teaching Newton's Laws?	Open-ended	Enhanced comprehension and awareness of formative assessment
	post-intervention questionnaire and Semi-structured interviews	Concept cartoons as a tool for instructors to use in formative assessments
		The assurance to carry out formative evaluation.

can help ease the hurdles involved in the implementation of formative assessment".

The use of Concept Cartoons enhanced comprehension of concept and supported the effective use of formative assessment as indicated in Table 10.

DISCUSSION

The reflections of the participants were elicited using semi-structured interviews and the participants' written post-implementation reflections. The semi-structured interviews were conducted after the implementation period where the participants had to use Concept Cartoons to implement formative assessment in their teaching. Analysis of the interview data and the written post-implementation reflections of the participants resulted in three themes, Concept Cartoons enhancing teaching, Concept Cartoons as formative assessment instrument for teachers, and Concept Cartoons instilling confidence in the implementation of formative assessment.

Improved their Formative Assessment Teaching

The interview data indicate that the participants' understanding of formative assessment improved, which is in line with their answers on the post-intervention questionnaire. The participants' written comments following implementation and their answers to interview questions suggest that this improvement extends beyond formative evaluation. It seems that the study had a knock-on impact, improving the participants' overall teaching abilities as well.

For instance, during the interview, participant TI 1 claimed, "There has been tremendous improvement in my teaching" Similarly, TI 4 said, "…yes, I have learned something new to enhance my teaching" and TI 2 noted, "This has given me a picture way of teaching. It's easier to show learners and for them to see what I'm saying. It is a better way of teaching".

The study's implementation phase gave the participants the chance to put the information and abilities they had learned in the workshop to use. This happened in real-time in their classes when they were utilizing Concept Cartoons as a tool for formative evaluation. It appears from participant comments made during the post-implementation interview that teacher learning has occurred. For instance, TI 3 said:

"There has been tremendous improvement in my knowledge of formative assessment and my overall teaching skills. The use of the Concept Cartoons to assess the learners' understanding of Newton's laws of motion has enabled me to put myself in the learners 'shoes' to understand how they are processing the knowledge".

The participants gained knowledge on how to perform formative assessments using Concept Cartoons, which was a novel tool for them. Through the process of implementation, the participants' knowledge from the workshop was expanded upon. For 4 weeks, they integrated formative assessment into their instruction in the classroom. The teachers who took part acknowledged an increase in their formative assessment knowledge and abilities. They asserted that as a result, their teaching improved and their students' learning rose. In the post-implementation thoughts, TI 7 wrote:

"I have learned a lot through my participation in this study. I have gained a better understanding of formative assessment, especially in the skill to practically apply formative assessment in my teachings using Concept Cartoons. I also noticed that this benefitted my learners".

This T7 response supported Kumi-Manu's (2021) assertion that professional development experiences help instructors become more knowledgeable and skilled while also having the potential to alter their attitudes and beliefs. The instructors' pedagogy is improved because of their newfound knowledge, abilities, attitudes, and beliefs, which unintentionally result in more student learning.

Improved Knowledge of Formative Assessment

Based on their replies to the questionnaire, it appears that every teacher surveyed firmly believed that the research enhanced their understanding of formative assessment. During the implementation phase, they used the information they had learned during the workshop about using Concept Cartoons in formative assessment. One of the participants, TI 8, described his progress in formative assessment knowledge during the interview sessions using the cliche, "Practice makes perfect." Participant TI 7 noted that "… through the workshop interactions and the implementation process, I learned a lot about formative assessment and how Concept Cartoon can help ease the hurdle involved in the implementation of formative assessment". Likewise, TI 1 said, in response to the interview question on how participants' knowledge of formative assessment had improved, that "this study has been beneficial to me. It introduced me to Concept Cartoons which is an alternative medium of formative assessment from what I used to know". Participant TI 4 supported this notion by adding, "Now I know formative assessment is to help you know how much and how deep the learners have grasped a concept." The process of implementing this instrument in their classrooms enabled the participants to integrate this new idea into their daily practice of teaching.

Improved Teaching and Assessment Skills

During the interview, the participants were asked if there had been an improvement in their teaching because of the engagements they had in this study. All the participants responded in the affirmative. For example, participant TI 4 noted that "*the use of Concept Cartoons has shown me another dimension of teaching not just formative assessment*". Likewise, TI 1 stated "Yes, there has been a tremendous improvement in my teaching" and TI 3 concurred "*Yes, I have learned something to enhance my teaching".*

Kennedy (2016) outlines four ways that Concept Cartoons might be utilized to support teacher learning in this study: giving instructions, offering a variety of solutions, helping teachers develop understanding, and obtaining specific information. According to Kennedy et al. (2016), a strategy is most likely to have a positive effect on student success if it best supports teachers in making strategic decisions and gives them insight. These two strategies may be more effective in fostering teacher learning as they support sound judgment and comprehension on the part of the teachers (Kennedy et al., 2017). These conclusions are supported by the study's findings, which show that participants had the chance to learn more about their instruction or teaching during the study's implementation phase. As mentioned by TI 5 in the reflections following the implementation:

> *"Learning to use Concept Cartoons for formative assessment has not only increased my knowledge and skill of formative assessment but has improved my interactions with my learners. Before now, my Physics lessons used to be so 'serious' that is a bit tense, but with the Concept Cartoons the learners were able to relax and talk".*

With the use of Concept Cartoons, the participants were able to facilitate formative assessment, which allowed their learners to actively increase their understanding of the concepts of force and motion. Concept Cartoons helped the participating teachers better understand how to use constructivist concepts in the classroom in this fashion.

Although it might be challenging to distinguish them in the classroom, elucidating and reorganizing learners' thoughts are frequently presented in the literature as two independent processes (Naylor and Keogh, 2017). Teachers may show how these two phases can be controlled in the classroom using concept cartoons, as this study found.

Furthermore, eliciting individual learners' ideas might be pointless if a teacher cannot manage or utilize those ideas in a normal lesson. Concept Cartoons helped to lessen this problem because when used in a lesson, "Concept Cartoons created a perception that the learners' learning experiences were individualized. This view was verified by TI 7, who noted, "*Concept Cartoons enabled me to assess all the learners at the same time and in manageable ways while they were arguing their viewpoints*". In this manner, Concept Cartoons helped the participants to stimulate a Constructivist learning environment, which is the kind of environment where learners actively build knowledge by participating in classroom discussions with each other and the teacher as a facilitator.

The participants in this survey had to put down the reasons why they agreed or disagreed with the Concept Cartoon character. In this manner, the students gave the justification for the position they were supporting. Thus, Concept Cartoons gave learners the chance to practice applying scientific concepts to various contexts and cultivating their capacity for creative thought (Naylor and Keogh, 2017).

In the classroom, concept cartoons can be utilized as diagnostic aids and as scaffolding. A range of instructional resources is needed in diverse classes with students from various backgrounds, according to Krajcik and Delen (2017). To better match their unique experiences, connect with their past or current knowledge, and suit their learning, what could work for one group of learners might need to be changed for another. To involve every learner in their educational experiences, the usage of Concept Cartoons as a formative assessment approach may be beneficial.

Another consideration is in Naylor and Keogh, (2017) warning that Concept Cartoon characters should be designed with characteristics that are not biased and that they should possess neutral appearances. The summary of the participant's perceptions of the use of Concept Cartoons in formative assessment after Concept Cartoons were highlighted as follows: entertaining, motivating, allowing better facilitation, encouraging talk; promoting thinking, providing confidence, helping to identify misconceptions, promoting better listening skills, providing fun in the lesson, and promoting self-confidence.

CONCLUSION

The overall results of this study indicate that Concept Cartoons may be utilized as an effective formative assessment tool in the teaching and learning of Physics, especially in the understanding of Newton's Laws of Motion, even though the qualitative answers in this study may be contested. The way the participants answered the many instruments used in the study to collect data demonstrated this. Although this study was conducted in a particular setting, it is thought that the findings apply to other situations where science is taught and learned generally. These new knowledge, skills, attitudes, and beliefs acquired by the teachers can then, in turn, improve their content knowledge and their pedagogy. The usefulness of this study can be seen in that it is an example of real teachers having authentic classroom experiences in real classroom situations.

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Instrument

Part A: Pre-intervention Questionnaires

Pre-Intervention Questionnaire

(Please complete the form and tick appropriate Figures)

Name of Participant: ----------

School of Participant: ----------

Qualifications of Participant: ----------

Years of teaching experience: ----------

1. What, in your opinion, is formative assessment? ----------
   ---
   ---
2. What are your thoughts or feelings about formative assessment? ----------
   ---
   ---
3. Have you been implementing formative assessment in your Physics lessons?

Yes		No	

   If yes, specify the frequency:

Very Often		Often		Not so often		Rarely	

   If no, or rarely, please give reasons ----------
   ---
4. What instruments have you used to implement formative assessment?

Test		Game playing	
Drawing		Model making	
Concept mapping		Other	

   If other, please specify ----------
5. Did you face any challenge(s) when using the instrument(s) you ticked or mentioned above?

Yes		No	

   If yes, specify ----------
   ---
6. Tell me about an experience you had when implementing formative assessment that you enjoyed/did not enjoy and why?

   ---
7. Have you ever heard of Concept Cartoons?

Yes		No	

Educative curriculum materials are 'things' that help with learning (in both teachers and learners). If you know of Concept Cartoons, do you think that they might be considered an educative curriculum material and if so why?

Part B: Post-Intervention Questionnaire

Post-Intervention Questionnaire

(Please complete the form)

Name of Participant: ----------

School of Participant: ----------

Qualifications of Participant: ----------

Years of teaching experience: ----------

1. Please rate the workshop in terms of its usefulness to you in terms of formative assessment. Please use the scale above

1 Not beneficial	2	3	4	5	6	7	8	9	10 Extremely beneficial

   Do you think the training you received during the workshop has added to your knowledge of formative assessment?

Yes		No	

   Please state reasons for your answer

   ---
2. How would you describe formative assessment now after the workshop?

   ---
3. How do you feel about using Concept Cartoons as formative assessment tool in your teaching?

   ---
4. Please rate your confidence in implementing formative assessment in your classroom.

1 Not confident	2	3	4	5	6	7	8	9	10 confident

   Please specify the reasons for your answer in item 5 above.

Part C: Semi-structured Interviews

semi-Structured Interview (After Implementation)

i. What is your current definition of formative assessment?
ii. How has your knowledge of formative assessment been improved as a result of this study?

Prompt: Compare your knowledge of formative assessment before and after the Intervention.

iii. What is your opinion of Concept Cartoons as an Educative Curriculum Material (ECM)?

iv. Have you been implementing formative assessment in your teaching using Concept Cartoons?

v. Did the learners understand the speech bubbles and what each character was saying?

Prompt: How do you know this?

vi. Did the Concept Cartoons encourage talk and discussion among the learners?

vii. Did the use of Concept Cartoon as a formative assessment instrument assist your learners to understand Newton's laws of motion?

Prompt: How do you know this?

viii. Please describe your experience during the implementation of formative assessment in your classroom using Concept Cartoon.

Prompt: Were there any positive results? Please explain.

Did you encounter any problems? Please explain.

ix. Do you think there has been an improvement in your teaching as a result of this study?

Prompt: How do you know this?

x. Would you continue implementing formative assessment in your teachings? Please give reasons.