

Students' Experiences of Tippy Tube Video-assisted Learning during the COVID-19 Lockdown in an Open and Distance Learning Environment

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Abstract

The University of South Africa (Unisa) College of Education (CEDU) set up Tippy Tube as an online educational video channel to engage lecturers around the country. The outbreak of the novel coronavirus (COVID-19), which was declared a global pandemic on 11 March 2020, imposed a lockdown period from February to August 2021. This article reports on a study that explored how the use of Tippy Tube optimised support to first-year mathematics education students at Unisa during the lockdown. Moore's Transactional Distance Theory (TDT) underpinned the study. The study used a qualitative research design to explore students' views on whether the Tippy Tube tool had optimised student support in the mathematics education module during the lockdown. The module has five units and five Tippy Tube videos were developed for each unit. Open-ended questionnaires were administered to 100 purposively sampled first-year mathematics education students. Only 21 respondents completed the questionnaires. Thematic analysis was then used to analyse the data from the open-ended questionnaire responses. The findings of the study revealed that Tippy Tube video-assisted learning had benefitted the students in mathematics education. Further, the study findings suggested that lecturers can consider using the Tippy Tube tool to teach students mathematics and other disciplines as they are able to replay the videos for the purpose of clarity if they did not understand the videos during live presentations.

Keywords: Tippy Tube; mathematics education; dialogue; structure; autonomy

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Introduction

Videos are a multimedia platform that have gained popularity with higher education institutions (HEIs). YouTube is a multimedia in a form of a video developed where users upload, publish and watch videos (Burgess and Green 2009) as a platform for users to record and share their own videos at no cost (YouTube 2013). In the same vein, Pratama, Arifin and Widianingsih (2020) assert that YouTube is not only a multimedia platform for individuals to share and upload videos, but can also be used in an education landscape to support students' learning (Schaper et al. 2014). Green et al. (2018) describe YouTube as a valuable source of content to supplement the existing materials in health management and policy. Videos in the education landscape are seen as pedagogical tools and a combination of theory and application (Nacak, Bağlama and Demir 2020).

Research has been conducted in using YouTube in the education landscape. Almurashi (2016) examined the effective role of the multimodal text in YouTube videos for teaching English; a study by Abbas and Qassim (2020) investigated how active and influential YouTube is in teaching English in Iraq; and Pratama, Arifin and Widianingsih (2020) and Kim and Kim (2021) examined how beneficial the use of YouTube is for language teachers to enhance the skills of students. Furthermore, Nacak, Bağlama and Demir (2020) determined student teachers' views on using YouTube for educational purposes, and examined the effectiveness of using YouTube to improve computer skills in education.

In addition, research has been conducted in different settings in the South African context. For example, Maziriri, Gapa and Chuchu (2020) investigated the perceptions of students using YouTube as an educational tool. Jordaan and Jordaan (2017) examined the use of YouTube videos as a reflection tool for a service-learning module. It can be inferred from these studies that the use of YouTube videos in educational settings has positive results in students' learning at HEIs.

Although studies have been conducted on the use of YouTube videos at HEIs which are residential universities, little attention has been paid to the use of online videos for open and distance learning (ODL) students. Studies have been conducted on the effectiveness of YouTube as a learning tool at HEIs (Abbas and Qassim 2020; Pratama, Arifin and Widianingsih 2020); students' views on the use of YouTube in the education landscape have been investigated (Nacak, Bağlama and Demir 2020); the use of videos as a reflection of student-centred education has been investigated (Santonova and Spassov 2019); and the value of YouTube videos promoting instructional practices at universities (Pham et al. 2017). The findings of these studies showed positive perceptions towards the use of videos, such as, they make learning fun; help teachers cover the content comprehensively; and meet students' interests. Tippy Tube is another type of video-assisted learning platform – other than YouTube videos – that has been introduced and can be used in teaching and learning settings for students at the Unisa College of Education (CEDU).

The aim of using Tippy Tube videos is to provide additional audio-visual student support at critical milestones of the teaching and learning journey. Unlike YouTube videos that are downloaded online, Tippy Tube videos are specifically developed and produced by lecturers of various modules to optimise student support and reduce the transactional distance between the lecturer and students. However, a comprehensive understanding of first-year mathematics education students' experiences of the use of Tippy Tube videos is required in order to improve teaching and learning practices in an ODL environment.

Literature Review

The literature review covers the importance of using YouTube videos but also potential pitfalls in educational settings. This is my understanding of what scholars have found in their empirical research about using YouTube videos in an educational context. Note that although in this study I focused on the use of Tippy Tube videos, I used literature on YouTube video sources to guide the study as I could not find any literature on Tippy Tube videos, and both YouTube and Tippy Tube focus on online videos.

YouTube Videos in Education

Abbas and Qassim (2020) posit that YouTube videos bring a fun element to teaching; attract the interest of the students; and help the students find learning encouraging and exciting. Almurashi's (2016) study found that the use of YouTube videos combines visual context with spoken language and develops students' abilities to enjoy and understand English lessons. Long, Logan and Waugh (2016) conducted a study with science course students' pre-learning experience and found that students have a positive attitude towards the use of YouTube videos.

Kim and Kim (2021) found that the use of YouTube videos leads to academic pursuit and engagement in that these videos develop content knowledge and English skills. Alakhudayidi (2018) highlights the benefits of using YouTube videos as attracting students' attention; generating interest in the subject; improving students' attitudes towards the learning context; building a connection with the students; fostering creativity; increasing collaboration; motivating students; making learning fun; decreasing anxiety about scary topics; and increasing understanding. Although studies have been conducted on the use of YouTube videos and highlighted their benefits in HEIs, little attention has been paid to the use of videos with students in an ODL environment and how they enhance learning. The current study focused on the use of videos to enhance learning in an ODL environment with first-year mathematics education students.

Drawbacks of Using YouTube Videos

Videos can be used in educational settings. However, several studies have outlined some pitfalls concerning the security and the validity of online videos (Abbas and Qassim 2020). Nacak, Bağlama and Demir (2020) have pointed out the following pitfalls:

students do not ask questions while watching the videos; students are removed from the social environment; and there is a risk of unreferenced knowledge on the subject presented. Among the pitfalls identified by Kremer, Brannen and Glennerster (2013) are the poor audio-visual quality of some videos; diffusion of technology; availability of digital gadgets; efficient use of information communication technology (ICT) tools; pedagogical issues; and access and quality of videos.

Some studies have suggested that teachers or lecturers be trained in the use of ICT tools, including online videos, in order to make learning more productive (Almurashi 2016; Pratama, Arifin and Widianingsih). Abbas and Qassim (2020) recommend that universities activate their websites and share videos on YouTube as a teaching channel. In addition, they suggest that teachers and students establish relationships through educational channels for topic and content videos.

Little research has been conducted on the use of Tippy Tube videos to optimise support to first-year mathematics education students at Unisa. Therefore, as a primary lecturer, I created and developed five Tippy Tube videos with the aim to optimise support to first-year mathematics education students to present five study units in order to reduce the transactional distance between the lecturer and students. It is therefore necessary to reflect on the extent to which using videos for learning among first-year mathematics course materials is effective. This study therefore focused on how the online videos I developed increased the degree of interactional dialogue, including student-content dialogue; the level of flexibility of the structure of course materials; and the level of student autonomy in order to decrease the transactional distance. I also reflected on my own practices in the developed Tippy Tube videos for improvement. In this article, I argue that the use of Tippy Tube videos can decrease the transactional distance by increasing the degree of interactional dialogue and the level of flexibility of course materials, while decreasing students' dependence on the lecturers for course materials.

The Theoretical Lens

To understand mathematics students' experiences of the use of Tippy Tube video-assisted learning, which is mainly used in distance education, I used Moore's (1997) Transactional Distance Theory (TDT) as the framework to underpin the study. Distance education utilises technology enhanced learning to mediate against distance learning. Moore's TDT constitutes three variable main variables, namely, interactional dialogue, structure and autonomy. The transactional distance is the psychological or communication space and time of the lecturer separated from the students that occurs in a planned or structured learning situation (Moore 1997). In this article, the students' experiences of using Tippy Tube video-assisted learning incorporated how these videos created interactional dialogue with the students, and how the strategies and methods used to deliver the content of the module supported students' learning and autonomy.

Moore (1997) identified the inverse relationships between the above-cited variables in his theory, namely, interactional dialogue, structure and autonomy. For example, an

increase in one variable can lead to a corresponding decrease in the other variables (McIsaac and Gunawardena 1986). Moore has indicated that when the dialogue between the teacher and learners decreases, it leads to inflexible course material and a decreased sense of autonomy, and then the transactional distance increases. Though Moore (1997) does not specify the threshold, he notes that the decrease in structure below a particular threshold increases the transactional distance owing to the potential for learner confusion or dissatisfaction.

Several research studies have generally confirmed the usefulness of Moore's TDT as a framework to analyse the distance education practice (e.g., Chen 2001; Force 2004). Considering that the current study was experimental in a classical sense, Moore's theory was relevant since it provided a lens through which I could assess the use of Tippy Tube videos to promote the quality of the interactional dialogue and decrease the transactional distance between the lecturer and students. The TDT was used as a frame of reference to develop the data collection instrument and to interpret and code the responses of the research participants. This universe of relationships was ordered into a typology that was shaped by three clustered variables controlling the extent of the transactional distance, namely: interactional dialogue, the structure of course materials, and student autonomy.

Interactional Dialogue

The first variable is interactional dialogue which refers to the interaction between the teacher and students when the teacher gives instructions and the students respond. Interaction and dialogue are similar and can be used synonymously (Moore 1997). The term "dialogue" describes a series of interactions that can possess positive qualities that other interactions might not have. Dialogue has three types of interactions, namely: teacher-student, student-student and student-content. Interactional dialogue is purposeful, constructive and valued by both teachers and students through communication media. In interactional dialogue, teachers and students are respectful and active listeners and are expected to improve their learning. In the context of this study, I used Tippy Tube videos that promoted student-content interactions to enhance students' learning. In addition, in this study, I aspired to understand students' experiences during dialogic interactions with the Tippy Tube video-assisted learning to engage with the course materials.

Structure of Programmes

The second variable is the structure of the programmes that determines how the teaching course materials are structured to be delivered to students, employing various communication media. The structure of course materials can express the level of flexibility or rigidity in educational objectives, teaching strategies and evaluation methods to accommodate the needs of individual students (Moore 1997). Tippy Tube videos were used in this study with the intention to reduce the transactional distance which can provide a little predetermined structure of course materials through student-

content interactions. The structure of course materials reflects how the content is delivered using strategies and methods to relatively open the structure to support individual interactions through interactional dialogue. In the educational fraternity, the structure of the programme has three main aspects which students need to possess, namely, practice, feedback and council.

Regarding the structure of the programme, students need to receive direction and guidance about the content through interactional dialogue to support individual interaction. In this study, I wanted to understand how Tippy Tube videos provide support to students in understanding the structure of course materials. With less or little dialogue, these directions and guidance would not be possible if course materials were tightly structured unless students modified this through interactional dialogue.

Student Autonomy

Course materials that are mostly dialogic and less structured suggest the success of students in learning the content of the materials independently, which is the last variable, student autonomy (Moore 1997). It is a sense of self-directedness or self-determination which can be affected by the degree of interactional dialogue and the level of flexibility or rigidity of the structure of course materials (Giossos et al. 2009). Moore (1997) argues that it has been empirically tested that more advanced learners are autonomous learners and are seen to be comfortable with programmes with less dialogue and less structure, while more dependent learners require programmes with more dialogue and a great deal of structure, and others prefer to rely on informal structure in a close relationship with the lecturer.

Tippy Tube videos are used with the intention to see if they can help students to approach the subject matter without the support of the teachers. In other words, I wanted to gain an understanding of how the structure of course materials and interactional dialogue could have made students independent of the teacher in learning mathematics by using Tippy Tube videos.

Rationale behind Using the TDT in an ODL Environment

This article emanates from the scholarship of teaching and learning (SoTL) in which I undertook an inquiry about students' learning through Tippy Tube videos at the Unisa CEDU. The SoTL in the context of this study focused on students' experiences using Tippy Tube videos to learn mathematics content to reflect on my own teaching approaches and strategies. The 2020 examination results of mathematics education students were found to be unsatisfactory and the 2021 cohort did not perform well in Assignment 01. I prepared five Tippy Tube videos on the teaching of quadratic equations and inequalities, number patterns and measurement to enhance learning and improving performance in these course materials. This study was aimed at diminishing the sense of transactional distance by implementing Tippy Tube videos to increase the degree of interactional dialogue; decrease the level of rigidity of the structure of course

materials; and increase student autonomy. I anticipated that the study would help me to determine how Tippy Tube videos can be used optimally to support students and to answer the research question: “How did Tippy Tube videos optimise support to first-year mathematics education students in an ODL environment?”

Research Methodology

Research Paradigm

The study followed an interpretivist paradigm with the aim of interpreting the meaning and experiences of the students in the use of Tippy Tube videos in learning mathematics as suggested by Williamson and Johanson (2018). These authors note that this paradigm reflects in practices that researchers should understand participants’ perspectives to deal with multiple realities. This study espoused a qualitative approach to describe the phenomenon under investigation, and unearth a new and deeper understanding of how Tippy Tube videos have supported learning in the first-year mathematics education student cohort group. Furthermore, Creswell and Creswell (2018) posit that qualitative researchers collect data on the site where the participants experience the problem under investigation. It is a process that the researcher gradually makes sense of a social phenomenon by contrasting, comparing, replicating, cataloguing, and classifying the object of the study (Williamson and Johanson 2018). A phenomenological design was employed consisting of 21 first-year mathematics education students providing a detailed description of their experiences in the use of Tippy Tube videos in their context. Creswell and Creswell (2018) maintain that phenomenology research enables the researchers to attempt to understand the participants’ experiences about the phenomenon under investigation.

Data Collection Procedures

The study was undertaken with students who were enrolled for the first-year mathematics education course at the Unisa CEDU in 2021. The data was obtained by administering an online questionnaire to a sample of 100 first-year mathematics education students (Johnson and Christensen 2012).

The collection instrument consisted of an open-ended questionnaire with 10 question items. The rationale behind using this instrument was that students could answer the questionnaire at a time convenient to them and is less intrusive than interviews (Williamson and Johanson 2018). The questionnaire items were guided by Moore’s TDT used to underpin this study. Although the questionnaire was designed to be completed within 20 to 25 minutes, the students were given two weeks to complete the questionnaires online and to return them in the third week. The students were requested to respond to the questionnaire in English as I used a non-homogeneous group in terms of language. Only 21 students returned their questionnaires and the analysis was done based on these returned questionnaires. Furthermore, the findings were not generalised as the students who returned the questionnaires could not represent the entire population.

In order to validate the data collection instrument, I used face validity by requesting two experienced researchers to review the open-ended questions to ascertain if they had captured the topic under investigation effectively. Furthermore, the experienced researchers checked if there were any confusing or leading questions.

Ethical Considerations

Permission was sought from the first-year mathematics education students to administer the questionnaires to them and also from Unisa for the students to participate in the study. The purpose and rationale behind the study was explained to the students. I was obligated to respect the rights, needs, values and desires of the students who participated in this study (Creswell and Creswell 2018). Anonymity and confidentiality were guaranteed to the students and they could withdraw from participation in the study without being prejudiced. The students were assured that the data from the questionnaires would be used solely for the purpose of the study.

Methodological Approach

The analysis of the data was a two-fold process, using Moore's (1997) TDT as the framework that underpinned the study. The first fold was analysed solely on the degree of the interactional dialogue (ID) variable, which included teacher-student interactional dialogue (TSID), student-student interactional dialogue (SSID) and student-content interactional dialogue (SCID), to either increase or decrease the transactional distance (TD). The second fold was analysed on the structure of course materials (SCM) variable, which is based on the level of the rigidity or flexibility of the structure of course materials of a mathematics education course, to either increase or decrease the TD. The complementarity of the two variables contributed towards either increased or decreased TD and increased or decreased student autonomy (SA) (see Figure 1).

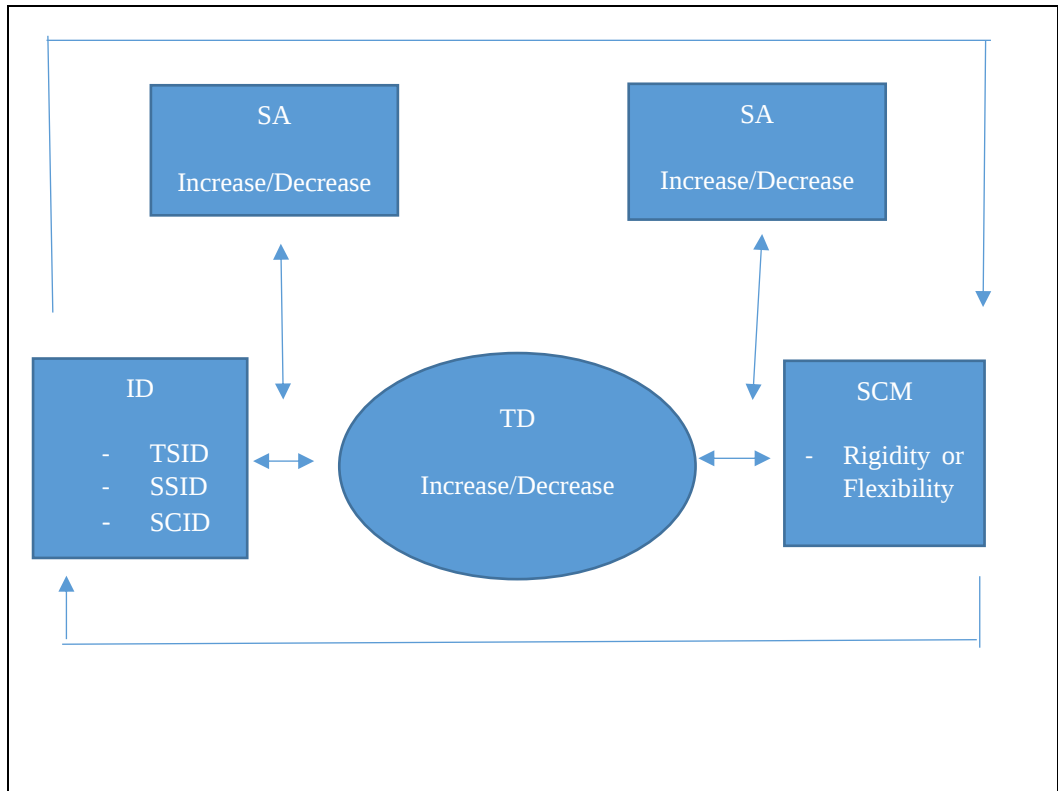


Figure 1: The dialogic approach to understanding the variables of Moore's TDT

Figure 1 shows student autonomy depending on the degree of interactional dialogue and the level of rigidity or flexibility of the structure of course materials to contribute to the level of student autonomy. In addition, the degree of interactional dialogue and the level of rigidity or flexibility can influence the level of transactional distance. When the degree of interactional dialogue (teacher-student interactional dialogue, student-student interactional dialogue and student-content interactional dialogue) increases, the level of the structure of course materials decreases and produces a high level of student autonomy and a low level of transactional distance. Conversely, a low degree of interactional dialogue (teacher-student interactional dialogue, student-student interactional dialogue and student-content interactional dialogue) increases the level of the structure of course materials which contributes to a low level of student autonomy and a high level of transactional distance.

Data Analysis and Interpretation

Out of the 100 students who received the open-ended questionnaire, only 21 returned their responses. To make sense and meaning of the data, according to Creswell and Creswell (2018), I organised and prepared the data from the questionnaire responses for analysis in a spreadsheet to read through the data. I repeatedly read through the data to

make sense of the information and reflection and I formed a general meaning of the patterns, themes and codes. The following themes emerged from the dataset: how Tippy Tube videos contributed to the interactional dialogue; how Tippy Tube videos contributed to the structure of course materials; how Tippy Tube videos contributed to SA; the relationships among the three variables (interactional dialogue, structure of course materials, student autonomy); and the shortfalls of Tippy Tube videos. Participant codes were used to protect the students' identities, for example, ST1 represents student teacher number 1, ST2 represents student teacher 2, and so on. The participants' quotes are given verbatim in the study.

How Tippy Tube Videos Contributed towards the Degree of Interactional Dialogue

The findings of this study revealed that teacher-student interactional dialogue was effective in enhancing the students' learning, and made learning easier, more fun and more accessible through videos. Furthermore, the study revealed that teacher-student interactional dialogue appealed to the students and their attention was drawn to the presentation of the structure of course materials. For example, ST2 commented:

Tippy Tube videos make us to pay attention to mathematics content.

While ST4 agreed:

Tippy Tube videos makes like easy and fun for us to learn mathematics.

These findings concurred with those of Pratama, Arifin and Widianingsih (2020) and Alakhudayidi (2018), namely, that the use of videos attracts students' attention to the course materials, which involve critical thinking and creativity. In addition, the findings supported those of the study by Abbas and Qassim's (2020) that the use of videos has an element of fun, attracts students' interests, and can encourage learning and make it more exciting.

Tippy Tube videos can be replayed to make sense of the structure of course materials presented by the lecturer. Moore (1997) argues that in distance education, using multimedia, the degree of interactional dialogue enhances students' learning and reduces the transactional distance. This can also make students adopt a positive attitude towards the use of videos (Long, Logan and Waugh 2016). Subsequently, this can decrease the students' level of anxiety about scary topics and increase their understanding (Alakhudayidi 2018). By replaying the videos, students become more motivated; and they are provided with an independent learning space. ST5 observed:

The use of Tippy Tube videos motivates us to learn mathematics as we can use them any time and space.

In the same vein, ST8 concurred by saying:

With videos we can learn anytime anywhere without boundaries.

This is supported by Chen and Wu (2015) who found that the use of videos provides independent learning and can occur anytime in any geographical location. Alakhudayidi (2018) asserts that videos can motivate students' learning through the interactional dialogue, in which it occurred in the teacher-student interactional dialogue and student-content interactional dialogue in the context of this study. This shows that learning through videos can take place irrespective of time and space by replaying the videos for the sake of clarifying mathematical content.

How Tippy Tube Videos Contributed towards the Structure of Course Materials

The findings showed that the use of Tippy Tube videos made the students understand and critically think about the mathematics content. Tippy Tube videos provided the students with lessons that could help them to understand how to teach mathematics for conceptual understanding, which was initially difficult for them to understand using everyday life problems to teach quadratic equations. For example, ST10 said:

Tippy Tube videos make one to better understand difficult topics of mathematics course.

Moore (1997) notes that the flexibility of course materials, through interaction with multimedia, can lead to a high sense of student autonomy and decrease the transactional distance. In other words, students found that the level of rigidity of the structure of course materials was reduced through watching Tippy Tube videos to learn independently, while their dependability on the lecturer (transactional distance) was reduced. These findings showed that the students were able to deal with challenging topics in a mathematics course, which in turn revealed the flexibility of the structure of course materials and decreased the transactional distance. Prior to the presentation of Tippy Tube videos, the students could not interpret word problems such as "Jack is five times as old as Mark. If Jack is x years old, how old is Mark?" and this could affect their abilities to teach this topic. For example, referring to word problems that needed to be interpreted, ST4 noted:

Tippy Tube videos allowed me to easily interact with my study materials.

In other words, the student-content interactional dialogue increased to produce the level of flexibility of the structure of course materials, which could lead to increased student autonomy and decreased transactional distance.

The level of flexibility of the structure of course materials in a mathematics course seemed to improve the students' problem-solving and critical thinking skills of the students.

For example, referring to activities that were given in the Tippy Tube videos, ST3 commented:

It teaches me how to think critically; I can think and solve any mathematical problems steps by steps.

Nacak, Bağlama and Demir (2020) support the idea that the use of videos can promote students' critical thinking and problem-solving skills and their interpretation of meaningful mental activities. Abbas and Qassim (2020) add that the use of videos can attract the students' attention and develop their mentality and creativity in the subject matter.

The findings further revealed that the level of flexibility of the structure of the mathematics course materials can increase the students' knowledge retention and improve their performance when using Tippy Tube videos. ST6 had this to say:

Videos increase student engagement with the course materials as we can play the videos back and forth to make sense of the content, which in turn helps boost achievement. If students are interested in the materials, they will process and remember it better.

Further, ST6 mentioned that students should also commit themselves to engage with the mathematics content for the purpose of increasing knowledge retention and improve performance. The use of videos in education improves performance and reinforces learning, according to Nacak, Bağlama and Demir (2020). In other words, if students commit themselves to their learning, then their learning is reinforced; knowledge can be retained and remembered; and they can deal with more complex problems in the mathematics course. The level of flexibility of the structure of course materials in the mathematics course through using Tippy Tube videos, can lead to a high sense of student autonomy which, in turn, can encourage students to engage with complex mathematical problems. Green et al. (2018) posit that videos are found to be a valuable source of content to supplement the existing course materials.

How Tippy Tube Videos Affected Student Autonomy

The findings of this study revealed that a high degree of interactional dialogue and a low level of rigidity of the structure of course materials can lead to a sense of student autonomy and a low transactional distance. Students can approach the subject matter without the support of the lecturer. When students can solve mathematical problems independently without the assistance of the lecturer or teacher, it shows a higher level of flexibility of the structure of course materials and increased interactional dialogue which lead to an increased sense of student autonomy and a decreased transactional distance. ST3 observed:

It helps us to learn independently and be well prepared for mathematical content.

This shows that the sense of student autonomy that is perceived can encourage students to effectively engage with the course materials (Moore 1997). A sense of student autonomy is supported by Abbas and Qassim (2020) who report that the use of videos could attract students' interests and make learning more encouraging and exciting. In this case, students can use different methods to solve mathematical problems independent of the lecturer or teacher. Most of the students started to participate in solving problems given in the Tippy Tube videos on MyUnisa and they were taught different methods in the platform to solve those problems given.

Relationships among the TDT Variables

The relationships among the TDT variables were found to depend on their inverse proportionalities in Moore's theory – interactional dialogue, structure of course materials and student autonomy. For example, McIsaac and Gunawardena (1986) posit that an increase in one variable can lead to a corresponding decrease in the other variable, or vice versa. From the finding discussed above, it has been revealed that the higher the degree of interactional dialogue that occurred with the Tippy Tube videos, the lower the level of rigidity of the structure of course materials, which could lead to a high level of student autonomy and a decreased transactional distance. Moore's (1997) theory argues that a decrease in interactional dialogue can lead to an inflexible structure of course materials and less sense of student autonomy and then an increased transactional distance. This idea is contrary to what was found in the current study.

The use of Tippy Tube videos in this study aligned with Moore's (1997) three variables – interactional dialogue, structure of course materials and student autonomy. For students to watch videos back and forth enhanced their learning in mathematics content. This was revealed when the students' interaction on MyUnisa about the content increased in the discussion forum. In other words, the use of Tippy Tube videos increased the interactional dialogue between students-students, students-lecturer and students-content.

For example, one of the students (protecting her identity in the discussion forum) asked:

How do we teach number patterns for conceptual understanding in Grade 11, especially quadratic sequence?

Students-lecturer interaction was revealed through emails students sent to the lecturer seeking clarity on the three contents presented. One of the students (protecting his identity the discussion forum) asked this question via email:

How do I differentiate [between] mass and weight in measurement?

The student needed clarity about the two concepts that were presented in the videos from me as his lecturer which showed an increased student autonomy in learning course materials. According to the findings of this study, the use of Tippy Tube videos

increased the degree of interactional dialogue and decreased the level of rigidity of the structure of course materials to increase student autonomy and decrease the transactional distance when studying mathematics. The three variables were seen to be interdependent in this study, the higher the degree of interactional dialogue (student-student, student-lecturer and student-content), the more the students could interact with the course materials flexibly and thereby increase their autonomy.

Pitfalls of Using Tippy Tube Videos

Although the use of Tippy Tube videos highlighted some positive effects, numerous pitfalls were also identified in this study, namely, poor network connectivity and a lack of money to buy ICT gadgets to watch the videos. This finding supported the findings of Kremer, Brannen and Glennerster (2013) that the pitfalls of using videos are the poor audio-visual quality of some videos; diffusion of technology; availability of digital gadgets; efficient use of ICT tools; pedagogical issues; and access to and quality of videos. Referring to the use of Tippy Tube videos in teaching a mathematics in education course, ST7 commented:

We experience poor signals for network connections.

ICT literacy was identified as another pitfall which tends to affect the interactional dialogue, structure of course materials and student autonomy when using Tippy Tube videos. Ferrer et al.'s (2011) study points out that students who are not familiar with ICT tools tend to perform poorly in their academic activities. For example, ST9 observed:

I struggle to download the videos and always need someone to assist me.

While ST3 agreed and said:

It's not easy to get those videos because we don't understand where we can get them.

This shows students' lack of ICT literacy to use ICT gadgets in order to gain access to study materials. It is argued that teachers or lecturers should be trained to know how to use ICT tools in order to make learning productive (Almurashi 2016; Pratama, Arifin and Widianingsih 2020), but this study revealed that even some students need to be exposed to this kind of training for productive learning.

Concluding Remarks

The study basically used Moore's TDT as the framework to underpin the study. The use of Tippy Tube videos showed the relationships among interactional dialogue, the structure of course materials and student autonomy that appear to have optimised support to first-year mathematics education students in learning quadratic equations, quadratic inequalities, number patterns and measurement in an ODL environment. In this empirical study, the variables were used to make sense and meaning of the collected

data which showed their inverse relationships. Their relationships showed that an increase in the interactional dialogue leads to a decrease in the structure of course materials, which then increases the students' sense of autonomy and decreases the transactional distance. Conversely, a decrease in the interactional dialogue and an increase in the structure of course materials can lead to a decrease in student autonomy and an increase in the transactional distance when presenting course materials to first-year mathematics education students. Based on the evidence found in this study, TDT can still be confirmed necessary in ODL. The theory provides a useful conceptual framework for defining and understanding distance education. Thus, the study proposes that empirical research can be conducted on the effectiveness of using Tippy Tube videos in teaching mathematics in an ODL environment.

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