

Video-based multimedia on learners' attitude towards astrophysics: Gender equity and school location

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ABSTRACT

Educational literature is richly provided with research confirming the benefits of video-based multimedia (VBM) in education. So, understanding learners' attitude about learning using video-based multimedia makes sense. A convergent parallel mixed methods research design was used to analyze and interpret learners' attitudes in the context of learning astrophysics using video-based multimedia. The research involved 294 students (168 male and 126 female) of senior five (grade 11) who purposively selected from eight public secondary schools in Rutsiro and Rubavu districts, Rwanda. Data were collected using a questionnaire (Cronbach alpha=.87), a semi-structured interview, and class observation. Quantitative data were analyzed using descriptive statistics and t-test ($P \leq 0.05$ level of significance) while content analysis was employed to analyze qualitative data. The findings revealed that there is no significant difference between male and female attitudes towards the use of video-based multimedia in learning astrophysics. Besides, the geographical location of the school influences the learners' attitude. The results revealed some factors that affect learners' attitudes towards learning astrophysics using video-based multimedia. Moreover, the findings recommend how the identified challenges could be alleviated not only in the Rwandan but in other science subjects worldwide.

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1. INTRODUCTION

Now, more than ever before, the world has witnessed an increase in the use of information and communication technology (ICT) in education [1]. The increase of technological infrastructure and ICT devices has enabled the use of ICT multimedia in many schools, thereby increasing the potential use of video-based multimedia (VBM) in teaching and learning science subjects such as physics [2]–[4]. There are shreds of evidence in recent studies that VBM is crucial to relevant and quality education [2], [4]. In science subjects such as physics, VBM has become a bedrock of quality teaching, improving instructional tools, and motivating learners to understand more the concepts [5]. In addition, the VBM tools can be used to enhance in-class teaching methods and to explain lessons for learners [3]. Moreover, the use of VBM increases learners' participation, motivation, and commitment which can surely shape their performance and attitude [5], [6].

Today, learners who are digitally native and who have been surrounded by digital devices since their elementary schools likely have a different attitude towards the use of technology in physics education from the preceding generation [7], [8]. In this regard, researchers from different countries have witnessed the importance of using computer and ICT-based multimedia including VBM in teaching and learning physics [2]. Even though many countries witnessed the importance of using technology in education, there are many factors that can handicap the successful use of ICT in education. Those factors include, but are not limited to, a national policy aiming at promoting the use of technology in education [9], availability of technology tools and infrastructures [10], technological literacy [11], gender equity [12], confidence, and personal pedagogical belief [13], and ultimately, students' attitude toward the use of technology in science [14]. Moreover, researchers in Science, Technology, Engineering Mathematics (STEM) education have described female attitudes towards technology as problematic [15]. Research findings from STEM education in sub-Saharan African countries identified barriers that females face in using technology. Those barriers are related to emotion, culture, and structure barriers [16]. Moreover, a previous study reported that students from urban areas have a more positive attitude than students from rural areas [17]. A recent study revealed that the geographical location (urban or rural) and ICT tools limit female access to technology [17]. In many countries, most ICT tools are focused in urban areas and there is a deficiency of sufficient infrastructures related to ICT in rural areas [18]. These provide a piece of comprehensive evidence that, generally, persons' attitudes towards technology would be determined by the geographical location.

In classroom settings, attitude means the individual tendency to react positively or negatively to a subject. Attitude determines what each individual will see, hear, think and do [19]. Attitude defines apparent and observable behavior as well as someone's convictions [20]. Learners' attitude finds its origin in the environment in which they live [21]. Indeed, it is built on a set of experiences lived or learned throughout their existence [22]. Research revealed that a positive attitude towards technology affects positively its use in classroom activities [23]. Several factors such as physical factors, environmental factors, and accessibility take part in the formation of a learner's attitude [24]. Hence, it makes it possible to understand how the learners manage to synthesize their beliefs towards a subject such as physics education due to the use of VBM and/or other ICTs multimedia [22]. Female attitudes towards ICT can deter them from using ICTs multimedia such as VBM for education purposes and consequently prevent them from achieving quality education in STEM through technology [24], [25]. A recent study has proposed reasons behind the negative attitude of females to use of technology in teaching and learning such as culture and accessibility [26]. Researchers revealed that the culture of ICT in STEM education is not friendly to female [27] and it was observed that computer culture was traditionally associated with male [28]. These conceptions of female that the culture of using ICT in education is friendly to male more than female can describe why female have negative attitudes towards ICT. Furthermore, researchers revealed that female experienced less access to ICT-related tools than male [29]. The organization for economic cooperation and development (OECD) argued that there is a gap between younger age groups in ICT accessibility in learning and that the male and female tend to use their access differently [30].

The government of Rwanda and its stakeholders in education recognized the effectiveness of ICT in increasing the relevant quality of teaching and learning science [31]. The government invested in planning and implementation of ICT in education spreading computers and internet connectivity in schools countrywide in both primary and secondary schools, increasing infrastructure and teachers' training about the incorporation of ICT in teaching and learning [32], [33]. The issue of the geographical location of technology facilities in Rwandan schools is less of concern because the government of Rwanda has a policy of ICT in education that is under implementation [32]. For example, in 2016, Rwanda education board (REB) started distributing laptops in schools countrywide and gradually provided internet connectivity and ICT course was introduced as an examinable subject in the ordinary level of secondary schools [34]. Furthermore, the issue of gender is less of concern not only in education but also in other corners of life because women and men are equal in terms of opportunities due to strong political will, policies to overcome gender gaps, and commitment to promoting gender equality and the empowerment of women by country's top leadership [34]. Moreover, gender equity has received great attention as the policies envisage to set the Rwandan society free from all forms of gender-based discrimination by creating an environment where both men and women equally benefit from the national development [35].

Research on the effectiveness of multimedia in teaching and learning physics was highlighted by several pieces of research carried out on international [2], [4], [6] and national level [5]. However, little is known about learners' attitudes towards using VBM in teaching and learning astrophysics topics. Based on the foregoing, this study sought to investigate the attitude of students towards learning astrophysics using VBM and to find out how this attitude could be influenced by gender and school location among selected secondary schools in Rwanda.

2. RESEARCH METHOD

2.1. Research design and paradigm

A convergent parallel mixed-method research design was employed in this research. In line with the pragmatic paradigm, this study combined quantitative and qualitative methods to gain an in-depth understanding of the topic. It also get more comprehensive data to answer the stated research questions and research hypotheses [36].

2.2. Sampling and research participants

Eight public secondary schools from Rutsiro district (Rural settled area) and Rubavu district (Urban settled area) in the western province of Rwanda were purposively selected for this study. Those schools were selected based on two conditions: i) They have smart classrooms (also called computer laboratory); ii) They have science combinations in the advanced level where physics is a major subject. These combinations include Mathematics-Physics-Geography (MPG), Physics-Chemistry-Biology (PCB), and Physics-Chemistry-Mathematics (PCM). In each selected school, all senior five (grade 11) classes with physics as a major subject from each school and all learners from each selected classroom were included in the sample. The choice of senior five students was done to strike the balance because it is a medium class in advanced level. Senior four students are new in advanced level and have not covered much while senior six, being a terminal class, students are busy preparing for the national examination.

2.3. Instruments and validation

The data reported in this study were collected using a video-based multimedia-astrophysics attitude questionnaire (VBM-AAQ). The VBM-AAQ items have been formed based on several attitude questionnaires and items were modified to suit the purpose and setting of the present study. VBM-AAQ was measured through 5 points Likert scale (1=strongly disagree, 2=disagree, 3=not sure, 4=agree, and 5=strongly agree). The questionnaire was subjected to a pilot study for validation and reliability analysis. Exploratory factor analysis (EFA) using SPSS version 21 was used for reliability analysis and construct validity. EFA was done using the principal component analysis extraction method which was performed to determine the number of factors that could be extracted from the 42 items of the initial questionnaire. 17 items were extracted and the remaining 25 had a factor loading greater than 0.40. The 25 items were analyzed for internal consistency and give a Cronbach's Alpha of .87 which was considered acceptable since it was greater than the recommended of .70 [37]. All 25 items were independent since they are no pair inter-item correlations of more than .80. To collect qualitative data, the semi-structured interview form to eight (four male and four female) randomly selected students in each school and the structured in-class observation form were used in eight schools. The purpose to conduct an interview and in-class observation was to understand the reasons behind participants' answers and to make a follow-up on learners' attitudes and beliefs about learning using VBM. Qualitative data collection tools were piloted and experts' views were used to validate the interview guide.

2.4. Procedure

The questionnaire was distributed to the learners in classroom settings during VBM teaching interventions which lasted four weeks. Each class received an intervention of four weeks including a continued assessment test. The interventions consisted of selected and edited YouTube videos using a projector and students' individual computers. To answer the questionnaire, participants worked individually under the supervision of class subject teachers. The time limit was 40 minutes equal to one class timetable period. The interview with randomly selected students was recorded using an audio recorder and note was taken during class observations which were done four times per class to mean once a week during VBM classroom setting in the smart classroom.

2.5. Data analysis

Descriptive analyses such as standard error, standard deviation, mean, and percentage were used to summarize data from the questionnaire. An independent samples t-test differences (at 95%CI differences) was also calculated to determine how the student's attitude toward learning using VBM varied between male and female, and urban student's vs rural students. Analysis of qualitative data was done by coding; in this case, we assigned as analytically and carefully as possible to each segment recorded (such as a sentence) the semantic category to which it refers [38]. Moreover, lesson observations were carried out to confirm whether what students reported in the questionnaire was a true reflection of reality. Class observation focused on students' motivation, active participation, and discussion about the raised misconception.

3. RESULTS AND DISCUSSION

3.1. Research participants

In this descriptive research, 294 senior five (grade 11) students aged between 16 and 21 willingly participated. Figure 1 shows the research participants by gender and by geographical location. Participants were from urban (Rubavu district) and rural (Rutsiro district) settled schools. 153 (76 female and 77 male) are from four public secondary schools in Rubavu district and 141 (91 male and 50 female) from four public secondary schools located in Rutsiro district. The average age is 18.1 years old. Learners are from three combinations: MPG, PCB, and PCM. Hence, Table 1 shows the distribution of participants per combination and per gender. There are 34.36% or 101 (50 male and 51 female) students are in PCB, 28.58% or 84 (51 male and 35 female) students are in MPG, and 36.40% or 107 (67 male and 40 female) are in PCM.

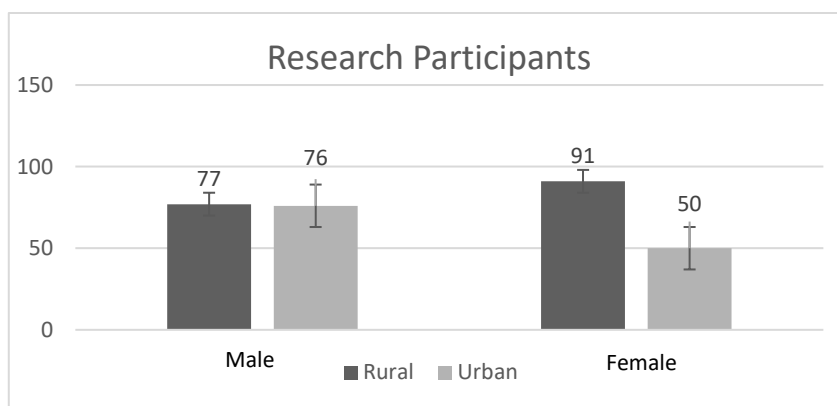


Figure 1. Research participants

Table 1. Respondents' distribution per combination, gender, and district

	PCB		MPG		PCM		Total
	Male	Female	Male	Female	Male	Female	
Rural Settled Schools	50	20	36	25	5	5	141
Urban Settled Schools	0	31	15	10	62	35	153
Total	50	51	51	35	67	40	294

3.2. Gender and school location learners' attitude towards the use of VBM in learning astrophysics

Learners' ratings for all the items' results are presented in Table 2 and Table 3. The tables show the overall mean, standard deviation, t-value, degree of freedom, and p-value. Results displayed in Table 2 indicate that there is no statistically significant difference in learners' attitude about learning astrophysics using VBM between male and female. The reasons are that the calculated p-value of 0.085 is higher than the 0.05 alpha level of significance while the t-calculated value of 1.727 is less than the t-critical of 1.96, a degree of freedom of 292. Their calculated used mean is 88.07 and 88.98 for male and female respectively indicating that gender effect has no significant influence on learners' attitude about learning astrophysics using VBM. Hence, the null hypothesis which states that there is no statistically significant difference in learners' attitude between male and female about learning astrophysics using VBM is hereby accepted.

Table 2. Independent samples t-tests for male-female

Variables	n	M	SD	t	df	p-value
Male	168	88.07	9.18	1.727	292	0.085
Female	126	88.98	11.52			

Table 3. Independent samples t-tests for urban-rural districts

Variables	n	M	SD	t	df	p-value
Rural	141	88.28	11.9	2.215	292	0.028
Urban	153	85.21	11.79			

These results could be interpreted by saying that the social construction of masculinity and femininity in students' attitudes towards learning science using ICT multimedia is less of a concern in Rwanda due to gender accountability at all levels in the country. Several previous studies echo similar findings on gender about learning science using ICT multimedia and technology in general that male and female have a similar attitude towards ICT [26], [39]. However, the results of this study contradict the findings of Volman and Eck who revealed that women have a negative attitude toward the use of technology in education [40]. Therefore, this could be interpreted to mean that there is a gap between women and young female who are digital natives in terms of positive attitudes towards ICT. Moreover, the results of this study also contradict the findings of the previous study that there is a significant difference between male and female attitudes towards technology in education [33]. Thus, this could be explained to mean that the attitude of male and female in using ICT is not like in the past; the reason for this statement is that the spread of ICT tools such as computers in Rwandan secondary schools increases the students' access to ICT and hence become attached to ICT in learning. This is in line with the theory of Zajonc which states that the time a person spent with an object determines his/her attitude toward that object [41]. Hence, the female and male realistic attitudes towards VBM in learning astrophysics are the same.

Results revealed in Table 3 also point out that there is a statistically significant difference in learners' attitudes about learning astrophysics using VBM between urban students and rural students. The calculated p-value of 0.028 (Less than the 0.05 alpha level of significance) and the t-calculated of 2.215 (greater than the t-critical value of 1.96) with a degree of freedom of 292 clearly showed that there is a significant mean difference between urban and rural students about learning astrophysics using VBM. Therefore, we reject the null hypothesis which states that there is no statistically significant difference in learners' attitude between urban and rural students about learning astrophysics using VBM. These results could be interpreted to mean that the students in urban settled schools access ICT facilitates outside the school more than students from rural settled schools. In general, ICT facilities such as communication centers, the latest technology, and smartphones are in urban more than in rural areas [18]. So, this raises the intrinsic motivation of urban students towards the use of ICT. As already mentioned, the more a person uses an object, the more is likely to respond positively to that object [41]. Researchers in other settings revealed that urban students show a positive motivation towards the latest cutting edge technology which is favored by the influence of the environment and this appreciates the effectiveness of VBM in their learning and other academic work [42].

3.3. Factors affecting students' attitude about learning astrophysics using VBM

In classroom observation, observers encountered an equipped smart classroom with a computer connected to the internet and projectors used by teachers to give instructions. Observers emphasized on five major variables as indicated in Table 4. Although the time allocated to VBM was limited, observers noted that the students' engagement and motivation increase as the time to use computers increases. A semi-structured interview was organized with randomly selected students at each school to learn more about the factors affecting learner's attitudes about learning astrophysics using multimedia. Learners' answers were assigned to segments recorded in the semantic category in which they refer, and items were listed in Table 5. Items are in decreasing order of the means recorded.

Table 4. Classroom observations notes

Variable	Observation notes
Teacher role	A mix of teacher-centered and learner-centered teacher roles
Amount of time during which the VBM was used	10 to 20 minutes per period (one period is 40 minutes)
Students' interaction with computers	Few students have difficulties with computers and most students struggled to get the right keywords when it comes to an individual research on YouTube videos
Students' engagement, active learning, and motivation	Very motivated and actively engaged in knowledge construction by creating the presentation, information analysis, and debate
Students' creativity and communication within the content	Individual and group research, debate, taking note and presentation of results

Table 5 reveals notable challenges from the participants on how students' satisfaction level to ICT tools, teachers' attitude and beliefs on possible benefits of teaching using ICT, social-economic attributes, environmental factors, and skills in using ICT facilities such as computers impede the students' positive attitude towards VBM in learning astrophysics. Firstly, based on findings presented in Table 5, it has been noted that many factors that impede the positive attitude of learners towards the use of VBM in learning. Both interviews and class observations revealed that the link between those factors is central to the satisfaction level of learners in terms of using ICT tools for educational purposes. Although ICT tools are

available, students' access to them is handicapped by lack of time. Moreover, sometimes teachers cannot use them because of a lack of ICT pedagogical skills associated with the pressure to finish the syllabus on time. This is not new, and it is not exceptional to the Rwandan context. Researchers reported that time for ICT practices and insufficiency of ICT tools in school together with teachers' availability and willingness to use ICT tools for education purposes affect learners' satisfaction in learning using VBM [13], [23], [43], [44].

Secondly, the socio-economic background of students associated with environmental factors also was identified as the factor affecting learners' attitude towards learning using VBM. Coming from different economic and social status families where some can have access to different ICT tools while others have to wait for school time brings different attitudes toward the use of VBM in learning. Environmental factors such as students' family residence (urban or rural) also affect learners' attitude towards the use of ICT multimedia in learning in favor of urban students because ICT tools are more available in towns than in rural areas. Recent studies have also cited similar challenges that geographical factors (urban or rural) affect directly the learners' attitude toward the use of ICT in education [10], [17].

Thirdly, the student's level of ICT tools and digital literacy also hinders their positive attitude towards learning using VBM. Together with poor communication skills, students' failure to express themselves was cited as factor inhibiting students' positive attitude to use VBM in learning astrophysics. Researchers echo a similar challenge that learners with a lower level of digital literacy were less likely to benefit from ICT multimedia such as VBM [7], [45]. To this, there is a need to understand that learners' computer literacy is the first stepping stone to effective integration of ICT in education that leads to effective use of ICT multimedia such as VBM.

Last but not the least, teachers' fear of failure makes them feel anxious about using technology in the classroom of learners who may be more technologically competent than them and thus not confident to use VBM in teaching and learning. This is associated with some teachers' belief that using ICT is too demanding in terms of preparation coupled with pressure to complete the syllabus. However, this is at variance with Rwandan new curriculum for secondary school physics which shows that one among the objectives of the new curriculum is to help students find things and develop skills out of themselves through research and with the fact that utilizing ICT in education is no longer a luxury but a necessity for development [31], [32].

Table 5. Factors affecting students' attitude

Item	Frequency (%)
Access to ICT (Time given to use smart classroom)	93.17
Teachers willing to teach using ICT	84.45
Socio-Economic factors	76.25
Environmental factors	66.63
Computer literacy	42.15

3.4. Suggested ways to overcome the identified challenges

Apart from reporting the factors that impede the learners' attitude towards the use of VBM in learning astrophysics, students made suggestions on how some of the identified challenges could be addressed. Students pointed out that developing the use of computer-based technology in everyday life and the use of ICT-based multimedia to support other learning approaches could have a noteworthy impact on raising students' attitudes and beliefs towards learning from VBM. This suggestion is consistent with what has been recommended by previous researches [46] that the access to and use of the internet and introducing blended learning increase students' motivation to science subjects and increase the scope of the search, hence raise the students' attitude to learn using ICTs multimedia and enhance learners' cognition in social constructivist learning settings.

Moreover, participants revealed that there is a need for teachers to change their minds about the usefulness of ICTs multimedia such as VBM in teaching and learning science subjects such as physics and scheduling enough time for this solemn teaching methodology. There is a need also to provide teachers with training aiming at effective incorporation of ICT in education and provide technical support in the smart classrooms and the whole ICT resources. Recent studies [6], [11], [26] echo similar findings that teachers should be oriented on how they can embed ICTs multimedia in their classrooms to effectively incorporate it, and previous studies [6], [7], [43] found out that new technologies technical supports in and outside the classroom is needed to create an environment where every student feels emotionally secure and supported.

4. CONCLUSION

This study aimed to investigate the students' attitude towards the use of VBM in learning astrophysics. The findings of this study indicated that female and male realistic attitudes towards the use of VBM in learning astrophysics are at the same level. However urban students have a more positive attitude towards the use of VBM than rural students. Moreover, the results of this study revealed that factors such as access to ICT tools, teachers' willingness to use ICT tools, socio-economic attributes, environmental factors, and ICT tools' literacy impede or increase the students' positive attitude towards the use of VBM in learning astrophysics. Drawing on classroom observation, there are needed clear instructions for students, assistance on how to choose the right keywords in research, and set goals to manage the classroom of students having different knowledge on ICT tools.





This study provides a reference point to effectively integrate ICTs multimedia such as VBM not only in Rwanda but also in other less developed countries. Most studies related to ICTs multimedia have been conducted in countries having advanced levels of technology, and the results could not be applied to underdeveloped world countries like Rwanda. Further research should critically explore the learners' attitude to other ICTs multimedia and how learners respond to other technological approaches in education without focusing on what was done in other countries with different levels of technology incorporation and use in education. Difficulties associated with ICTs multimedia in education could be another point that needs more research.

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