A Review of Computer Science Resources for Learning and Teaching with LSPU Computer Science Graphics and Visualizations Curricula

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Abstract

To help curriculum implementation and resource development projects for the Laguna State Polytechnic University - San Pablo City Campus (LSPU-SPCC), an assessment framework was utilized to review and evaluate the quality of existing Bachelor of Science in Computer Science (BSCS) resources for classroom learning and instruction. The study also aimed at finding out whether availability of teaching and learning resources influenced the implementation of BSCS Graphics and Visualizations Curricula. Researchers also used a descriptive research design of survey type and collected data using questionnaires. The sample of this study comprises: Computer Science instructors and students of LSPU-SPCC. Seven instructors and 83 (87%) out of 94 third year and fourth year students currently enrolled in the said program participated in the study. Descriptive statistics of means, percentages and weighted averages were used in analyzing the data. The study findings indicated that there was adequacy of teaching and learning resources at LSPU-SPCC. The outcomes of the review and evaluation show that several resources had an adequate degree context, integrity and alignment. The study recommends that sufficient teaching and learning resources should be offered to ensure that the Graphics and Visualization Curriculum is implemented effectively, and additional funding should be allotted for the purchase of teaching and learning materials for BSCS students.

Keywords: Graphics and Visualization; Computer Science; Curriculum; Education Resources; Education; Teaching Learning Resources

Introduction

Computer graphics is a large field of study that deals with the creation and modification of images and virtual objects using computers. Computer graphics, like many other aspects of computers, has advanced rapidly in recent decades (Gonzales, Sanchez & Arnedo, 2019). Because it requires a wide range of skills, including mathematics, programming, physics, cognitive psychology, spatial thinking, problem-solving, human-computer interaction, and art and design, computer graphics is a difficult subject to teach and learn (Suselo & Luxton, 2017). Graphics and visualization are a relatively new topic in terms of learning and teaching, and universities introducing new computer curricula confront the difficulty of preparing teachers to successfully apply computer science activities. Instructor preparation, including content and skills knowledge, as well as the availability of learning and teaching resources and teacher support, have all been noted as common issues with computing curriculum in a variety of situations (Bell & Robins, 2014)

Many institutions have begun to offer Computer Science courses centered on Graphics and Visualization, including Laguna State Polytechnic University-San Pablo City Campus. Finding suitable classroom resources when a new curriculum is offered is hard and can be difficult for instructors, especially if they have never been exposed to Graphic and Visualization training. Instructors can use a variety of internet resources, but one of the obstacles for educators is determining whether the resources are appropriate and of good educational quality. Appropriate professional development and the availability of high-quality learning and teaching resources to assist classroom implementation will be critical factors in the success of implementing a new computer curriculum.

The effectiveness of an educational system is determined by the adequacy of teaching and learning resources. Teaching and learning resources could be characterized as the instruments of presentation and transmission of the prescribed educational information in the context of classes as an institutionalized form of teaching and learning (Busljeta, 2013). Horsley (2015) found that in terms of resource use, textbooks continue to be the most often used teaching and learning resources in the classroom. According to Akungu (2014) the most cost-effective input affecting student performance is the adequacy of instructional resources such as textbooks, which are the major instruction material. A 2016 study by the Harvard Education Policy Research Center found high achievement gains for students using top-quality textbooks. In order to teach introductory programming, textbooks are essential. They are a valuable source of example programs as well as a guide to solving specific difficulties. (Borstler et al., 2010).

The purpose of this study is to determine the availability and suitability of Computer Science materials to aid in curriculum implementation.

Objectives

The objective of the study is to identify the resources needed and where efforts in terms of resource development can be directed in the future. Specifically,

1. to find out what resources are accessible for undergraduate Computer Science students, organized by year and subject
2. to determine the educational quality of resources
3. to find out whether availability of teaching and learning resources influenced implementation of Graphic and Visualization curricula

Literature review

Computing Curricula

It can be difficult for institutions introducing new computing curricula to have teachers ready to implement computer science activities because the study and teaching of computer science graphics and visualizations is still a relatively new discipline. Common issues have been recognized as teacher preparation, including knowledge of subject and abilities, the availability of resources for learning and teaching, and teacher support. Teachers are crucial to the implementation of any new curriculum since they are the key information carriers for students. (Gal-Ezer & Stephenson, 2014). A study conducted by Black et al., (2013) revealed that many respondents emphasized concepts concerning support for teachers. The requirement for strong topic knowledge in Computer Science teachers was acknowledged by several respondents, who believed that this was lacking or that additional support might be provided to otherwise competent teachers to advance their Computer Science expertise.

Teaching and Learning Resource

The term "teaching-learning resource", according to Adjei (2015) in his work on teaching and learning resources for teaching business management, refers to the materials that teachers utilize to convey instructions. Teaching-learning resources are tools that classroom teachers use to help their students learn fast and completely. They refer to a spectrum of educational materials that teachers employ in the classroom to support specific learning objectives as laid out in lesson plans. A simple chalkboard or a computer software can be used as a teaching aid. They are the tools that are employed in the classroom to impart information. Teaching and learning resources are materials that a teacher employs to help his students learn, understand, and acquire knowledge, concepts, principles, or abilities. In a nutshell, teaching-learning resources are tools that aid in providing vivid visual, auditory, tactile, manipulative, and demonstration experiences.

Teaching-learning resources enhance and aid student learning. It aids students in comprehending and enjoying the lesson that the teacher is teaching them. It aids students in comprehending the lesson's main point.

Furthermore, teaching-learning resources assist the teacher in determining whether the pupils have improved their comprehension of the subject. However, creating teaching-learning resources takes time, money, and effort. Only a few teachers have been exposed to teaching-learning resources. Teachers are not educated to use teaching-learning tools during their first training, making it difficult for them to apply them in the classroom. Teachers continue to use the traditional teaching style, which makes pupils passive participants in the course and stifles creativity. With teaching-learning resources, the learner-centered teaching style reveals a good and substantial link. Due to the fact that this teaching approach necessitates the use of specialized resources, a lack of these resources will obstruct its utilization. (Adjei et al., 2015)

While learning resources might include any of the following: textbooks, software, relevant reading materials, videos and recordings. Teaching resources in this study refer to curriculum materials that focuses on textbook.

Textbook

A textbook or other non-textbook materials are needed for nearly all courses (98%) as a component of the resources they need to have. The majority of required textbooks (69%) are printed rather than digital. (Allen & Seaman, 2016)

According to a study, while some physical facilities and teaching and learning resources are adequate, their underutilization and the inadequacy of other essential facilities and resources, like libraries and course textbooks, prevent community colleges from providing effective teaching and learning (Kigwilu & Akala, 2017).

There is a lot of literature that acknowledges the value of textbooks in the teaching and learning process. Textbooks give the teaching and learning process structure and order, and in the classroom, they are seen as valuable and effective tools or instruments whose goal is to facilitate the everyday job of the instructor. Additionally, textbooks give new teachers security and confidence. (Makori & Onderi, 2014)

Access to relevant textbooks is critical to a student's learning. These resources serve as learning aids for students. It assists students in understanding lessons by allowing them to follow the teacher's presentation sequence. Due to a lack of textbooks, students were hindered in their understanding of the material given, as well as competing class exercises and assignments. As a result, low academic performance. In addition, according to the Okongo et al (2015), institutions that have appropriate resources, such as textbooks, have a higher probability of doing well on exams than those that are underequipped. As a result, subpar teaching and learning resources and tools could be to blame for poor performance.

Moreover, a student's effort to study is not greatly aided by the lack of teaching and learning resources, such as the suggested textbooks and a good collection of library books. There is no comfort in the fact that many schools lack materials in both print and electronic form. They actually make a negative contribution to all students' total education. The students' lack of direct access to learning resources that would support the teachers

in creating a high-quality teaching and learning environment is caused by the very low textbook to student ratio (Webmaster, 2014).

Methodology

Research Design

This research study involves a review of available Graphics and Visualization resources suitable for classroom teaching and learning, using the Bachelor of Science Graphics and Visualization Curricula focusing on its Professional Electives or Specialization Tracks. The study also employed descriptive survey research design.

Respondents

The participants of the study included Bachelor of Science in Computer Science (BSCS) instructors and students from Laguna State Polytechnic University - San Pablo City Campus. Seven instructors and 83 (87%) out of 94 third year and fourth year students of Bachelor of Science in Computer Science (BSCS) students participated in the study. These students are enrolled in the Academic Year 2021-2022. The respondents are composed of 63.9% males and 32.5% females, while 3.6% of respondents prefer not to state their sex identity. The respondents are undergraduate students with 57.8% third year and 42.2% fourth year students.

Instrument

Questionnaires were used to collect data and to see if the availability of teaching and learning resources influenced the implementation of Graphics and Visualizations Curricula. The items in this scale were modified from the study of Okongo et al (2015). This scale is measured on a 5-point Likert scale from 1– “Strongly Disagree” to 5 – “Strongly Agree”

The focus of this study is to review Graphics and Visualization resources and present it what would be available if students had searched the library. The researchers involved in this study included the Associate Dean of the College of Computer Studies who is an Assistant Professor 1 and the other researcher with a background as a subject expert. The said researchers assessed the list of professional books used as references by the BSCS Graphics and Visualization instructors for A.Y. 2020-2021 and A.Y. 2021-2022 for Professional Electives or Specialization Tracks. The LSPU San Pablo City Campus Online Public Access Catalog (OPAC)were utilized to determine if the resources are available. The researchers also visited the university library to inquire directly if resources used in teaching professional electives were available.

The researchers curated the Professional Electives or Specialization Tracks resources used by the previous and current instructors for this study. Eleven identified resources were initially curated and recorded by the researchers. Duplicates were removed, leaving BSCS resources relevant to the Graphics and Visualization Track. For review, the resources were shared among the researchers. The researchers met on a

regular basis to guarantee uniformity by establishing a shared understanding of the review. A set of indicators on a Quality Assessment Framework were used to evaluate the Computer Science resources. The items were based on the study of Falkner and Vivian (2015). The assessment examined the resources according to three major components. The assessment looked at the resources from three perspectives. These included determining the resource's context, integrity, and alignment. The reviewers were to indicate whether the resource contained evidence of these standards by picking "no," "somewhat," or "yes." The average findings for each component were then converted into numbers, with "0" indicating "no," "1" representing "somewhat," and "2" representing "yes."

Table 1. Quality Assessment Framework

Principle	Element	Description
Context	Relevant	Is the resource explicitly relevant to the intended audience? Is the resource purposeful and meaningful?
	Inclusive	Is the resource inclusive of age, race, culture, gender or location?
Integrity	Disciplinary	Does the resource include and use Computer Science disciplinary language/symbols and content?
	Accurate	Is the information accurate and/or from a reputable source?
	Current	Is the content current and up-to-date?
	Open	Is the resource accessible?
Alignment	Evaluative	Does the resource include assessment guidelines or an element of evaluation?
	Interdisciplinary	Does the resource draw connections with other learning areas and/or skill development?
	Embedded	Is the resource mapped to curriculum or Teacher Professional Standards?
	Explicit	Is the resource explicit about the purpose, process

		and intended outcomes required of learning/ development? Are these clearly defined and labelled?

Data Collection

The researchers conducted an online survey using Google Forms. The online survey was delivered to participants through email, along with an informed consent form that stated that participation was voluntary and that their replies would be kept with high-confidentiality. This method was chosen because to its cost-effectiveness and ease of distribution. The questionnaires were separated into two groups: students and instructors.

Data Analysis

The researcher used descriptive statistics such as weighted mean with corresponding verbal interpretation.

Results

The Table 2 presents the list Professional Electives or Specialization Tracks of Bachelor of Science in Computer Science (BSCS) Graphics and Visualization and the professional books used as references for A.Y. 2020-2021 and A.Y. 2021-2022.

Table 2. List of Professional Books organized by book and year level

Course Code	**Course Title**	**Book Description (Author/s, Copyright date, Author/s)**
Third Year First Semester		
CSST 101	Basic Rendering (GV 101)	Zeman, N. B. (2014). *Essential Skills for 3D Modeling, Rendering, and Animation*. CRC Press. Birn, Jeremy(2014). Digital Lighting and Rendering (David Lopes' Library)
CSST 102	Geometric Modelling (GV 102)	None
Third Year Second Semester		

CSST 103	Advanced Rendering (GV 103)	Akenine-Moller, T., Haines, E., & Hoffman, N. (2018). *Real-time rendering*. AK Peters/CRC Press. Birn, J. (2014). Digital Lighting and Rendering (David Lopes' Library) Zeman, N. B. (2014). *Essential Skills for 3D Modeling, Rendering, and Animation*. CRC Press. Angle, E., & Shreiner, D. (2011). Interactive computer graphics: A topdown approach with shader-based opengl.
CSST 104	Computer Animation (GV 104)	Parent, R. (2012). Computer Animation. Algorithms and techniques/Parent Rick. Akenine-Moller, T., Haines, E., & Hoffman, N. (2018). *Real-time rendering*. AK Peters/CRC Press.
Third Year Inter Semester		
CSST 105	Visualizations (GV 105)	Hansen, C. D., & Johnson, C. R. (2011). Visualization Handbook. Elsevier Inc. Telea, A. C. (2015). Data Visualization: Principles and Practice (2nd ed.). CRC Press.
Fourth Year First Semester		
CSST 106	Mixed, Augmented and Virtual Reality (GV 106)	Sherman, W. R., & Craig, A. B. (2018). *Understanding virtual reality: Interface, application, and design*. Morgan Kaufmann.

It can be found in the list of professional books used in the teaching of Graphics and Visualization that there is no resource for the subject Geometric Modeling.

Table 3. Availability of Professional Books in the University Library

Course Title	Number of Professional Books used	Availability of printed book	Electronically available
Basic Rendering (GV 101)	2	0(0%)	2 (100%)
Geometric Modelling (GV 102)	0	0(0%)	0 (0%)
Advanced Rendering (GV 103)	4	0(0%)	3 (75%)
Computer Animation (GV 104)	2	0(0%)	1 (50%)
Visualizations (GV 105)	2	0(0%)	0 (0%)
CSST 106	1	0(0%)	0 (0%)
Mixed, Augmented and Virtual Reality (GV 106)	11	0(0%)	6 (55%)

The table above presents the availability of printed books in the university. Based on the data in Table 3, it reveals that the printed professional books used in teaching and learning Graphics and Visualizations are not available. 55% of the main reference were available electronically in the University Library. LSPU San Pablo City Campus Online Public Access Catalog (OPAC) were utilized to determine the number of books available electronically.

In contrast to the provision of electronic information resources by academic libraries, undergraduate students continue to find value in and use print information resources (Sun, Loh & Nie, 2021). This research results will be highly useful to publishers, librarians, and educational service providers in making decisions about how best to manage and invest in library resources to support teaching and learning.

Quality Assessment

The ability of a resource to successfully foster students' and teachers' learning and growth is what is meant by educational value. Resources were evaluated using the Quality Assessment methodology based on three main factors to understand the educational value of the curriculum resources. These included determining the resource's integrity, alignment, and its context. By choosing "no," "somewhat," or "yes," the reviewers were to identify whether the resource contained evidence of these standards. In order to show average findings for each component, these strings were eventually translated into integers, with "0" denoting "no," "1" denoting "slightly," and "2" denoting "yes."

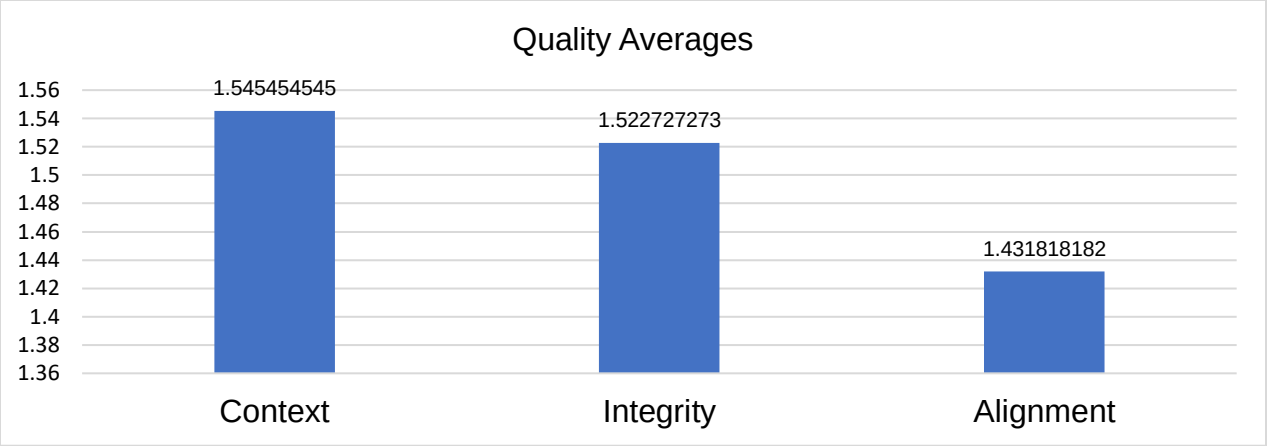

Figure 1. Quality assessment averages

The outcomes show that several resources had an adequate degree context, integrity and alignment.

The quality assessment components and the conclusions for each component are covered in more detail in the section that follows.

Context

Table 4. Analysis of Quality Attribute Assessment – Context

	Relevance		Inclusivity	
Yes	10	90.91%	2	9.09%
Somewhat	1	9.09%	9	90.91%
No	0	0%	0	0%
Total	11	100%	11	100%

The materials (90.91%) were determined to be pertinent to the target audience, teacher and student needs.

The extent to which materials can be altered to accommodate a range of situations and requirements, as well as their availability in several languages, were considered indicator of a resource's "inclusivity." Majority of the resources (100%) were identified as somewhat inclusive of age, race, culture, gender or location. It must be noted that the researchers are not usability specialists, hence assessments were made using fundamental ideas and information.

Integrity

Table 5. Analysis of Quality Attribute Assessment – Integrity

	Disciplinary		Accurate		Current		Open	
Yes	10	90.91%	10	90.91%	4	36.36%	0	0%
Somewhat	1	9.09%	1	9.09%	7	63.64	10	90.91%
No	0	0%	0	0%	0	0%	1	9.09%
Total	11	100%	11	100%	11	100%	11	100%

When information can be independently verified, when it originates from a reliable source, and when any theories, hypotheses, viewpoints, or points of view it conveys are clearly stated, a resource has integrity. This principle acknowledges that the integrity of the resource is a critical component of its educational value. The researchers acknowledged that this principle recognizes that a resource's educational value is critically dependent on its integrity.

The "integrity" component involved assessing the resource's accuracy, timeliness, and reliability as well as its usage of computer science-specific terminology. This component also involved determining whether the material is available. The majority of sources (63.64%) were current and (90.91%) offered accurate information from reliable sources.

Additionally, a lot of the resources had employed terminology related to computer science, and there were no problems with the materials' accuracy. The reviewed resources use the terms, symbols, and modes of representation specific to the field or topic, and aids students and educators in creating and utilizing them. It also encourages users to have a deeper understanding of the subject or field

A problem arose when a resource assumed teachers or students possessed the necessary disciplinary understanding of computer science principles or programming, despite the fact that many resources utilized specific computer science language. It may be difficult for teachers to explain and teach the concepts while also assisting students with their learning when resources presume a certain degree of understanding. Majority (90.91%) of the resources are somewhat available.

Table 6. Analysis of Quality Attribute Assessment – Alignment

	Evaluative		Interdisciplinary		Embedded		Explicit	
Yes	8	72.73%	7	63.64	7	63.64	10	90.91%
Somewhat	0	0%	4	36.36%	4	36.36%	1	9.09%
No	3	27.27%	0	0%	0	0%	0	0%
Total	11	100%	11	100%	11	100%	11	100%

Finding the extent to which resources contained an element of assessment or evaluation was called "alignment". Additionally, this component looked at if there were any clear connections to other learning domains (interdisciplinary). This component assesses how well the resource describes the desired learning outcomes, objectives, and teaching and learning procedures.

About 27.27% of resources lacked an assessment or evaluation component. In addition, 72.73% of the books included comprehensive assessment. The creation of supplemental materials, however, might help with their integration into classrooms for learning and teaching reasons.

The State of the Availability of Teaching and Learning Resources for the Implementation of Graphics and Visualization Track

Table 7. Availability of Teaching and Learning Resources according to students

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Interpretation
There is adequacy of Teaching and learning Resources in LSPU-SPCC	0 (0%)	4 (4.8%)	17 (20.5%)	41 (49.4%)	21 (25.3%)	3.95	Agree
The procedures of acquiring the resources for teaching and learning are very rigid.	1 (1.2%)	12 (14.5%)	26 (31.3%)	28 (33.7%)	16 (19.3%)	3.55	Agree
Lack of Teaching and Learning Resources Influence the Implementation of Graphics and Visualization Track	4 (4.8%)	21 (25.3%)	23 (27.7%)	14 (16.9%)	21 (25.3%)	3.33	Neutral

Legend: 1-1.8 –Strongly Disagree; 1.9-2.6 – Disagree; 2.7-3.4 – Neutral; 3.5-4.2 – Agree; 4.3-5 – Strongly Agree

The researchers sought to investigate adequacy of teaching and learning resources Bachelor of Science in Computer Science (BSCS) Graphics and Visualization. Out of 83 students, 41(49.4%) agreed with the statement that there were adequate teaching materials and resources in Laguna State Polytechnic University-San Pablo City Campus. Twenty-eight (33.7%) agreed with the statement that the procedures of acquiring the

resources for teaching and learning are very rigid. The study findings indicated that there was adequacy of teaching and learning resources in the Laguna State Polytechnic University – San Pablo City Campus but majority of the students were undecided whether this has an effect on the implementation of Graphics and Visualization Track. A total of 23 (27.7%) students were undecided with the statement.

Table 8. Availability of Teaching and Learning Resources according to instructors

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Interpretation
There is adequacy of Teaching and learning Resources in LSPU-SPCC	0 (0%)	2 (28.57%)	0 (0%)	3 (42.86%)	2 (28.57%)	3.71	Agree
The procedures of acquiring the resources for teaching and learning are very rigid.	0 (0%)	1 (14.29%)	2 (28.57%)	3 (42.86%)	1 (14.29%)	3.57	Agree
Lack of Teaching and Learning Resources Influence the Implementation of Graphics and Visualization Track	0 (0%)	1 (14.29%)	1 (14.29%)	4 (57.14%)	1 (14.29%)	3.71	Agree

Legend: 1-1.8 –Strongly Disagree; 1.9-2.6 – Disagree; 2.7-3.4 – Neutral; 3.5-4.2 – Agree; 4.3-5 – Strongly Agree

Findings from among the instructors indicate that 3(42.86%) agreed with the statement that there were adequate teaching materials and resources in Laguna State Polytechnic University-San Pablo City Campus. Three (42.86%) instructors agreed with the statement that the procedures of acquiring the resources for teaching and learning are very rigid. The researchers also sought to investigate whether the university face a lot of challenges when acquiring learning resources. Among the 7 instructors who responded to this question 3(42.86%) students agreed with the statement. A total of 4 (57.14%) instructors agreed that lack of teaching and learning resources Influence the Implementation of Graphics and Visualization Track

Conclusions

This evaluation looked at two elements of Computer Science resources: the type of professional books available and the educational quality of the resources. This overview of online computer science resources intends to help curriculum implementation and resource development projects for the said institution.

A Quality Assessment Framework of Falkner and Vivian (2015) was used as part of this review to assess the suitability of Computer Science resources for the educational setting, their integrity with the Computer Science discipline and their connection with curriculum objectives. The research's findings show that there are a lot of materials that have been contextualized correctly for use in learning, teaching, and professional development. The outcomes show that several resources had an adequate degree context, integrity and alignment.

The study revealed that there were adequate learning resources in Laguna State Polytechnic University – San Pablo City Campus. Lack of adequate teaching and learning resources affects the implementation of Graphics and Visualization Track.

In conclusion, teaching and learning resource, particularly textbooks, provide valuable knowledge that must be made easily accessible in order to supplement the teacher's own resources and experiences if they are to provide a great education to the next generation of computer scientist. Institution must not expect excellence in student learning as long as the textbook per student ratio is low as a basic indicator of the availability of reading materials. As long as students are prohibited access to reading books, library books, and, most significantly, mandated textbooks, the teacher's quality instruction is not supplemented by quality learning possibilities afforded by reading.

Recommendations

In the light of the findings of the study the following recommendations were made:

1. The administration and stakeholders must continually support LSPU-SPCC in providing Teaching-Learning Resources, particularly textbooks, whether it is printed or electronic, so that they become available in the university and to ensure effective implementation of the said curricula
2. The educational authorities should ensure that teaching-learning resources are updated to suit current teaching trends and ensure varieties as well.
3. To determine the effectiveness of the various types of teaching-learning resources in teaching and learning Computer Science Graphics and Visualizations in the LSPU-SPCC

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