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Perception of Library Resources and Utilization Among Tertiary Institution Students in Akwa Ibom State, Nigeria

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Abstract

The study examined perception of library resources and utilization among tertiary institution students in Akwa Ibom State, Nigeria. Specifically, the study seeks to determine if: Perception of print resources influences students' utilization of library resources; Perception of e-resources influences students' utilization of library resources; Perception of audiovisual resource influences students' utilization of library resources; and Perception of reference resources influences students' utilization of library resources. Ex-post -facto research design. The choice of the ex-post -facto design over other designs was basically due to the fact that the phenomena under study had already occurred. The population of this study consisted of 6,000 registered library users from five tertiary institutions in Akwa Ibom State, Nigeria. The sample used a total of six hundred (600) respondents i.e. ten percent (10%) from each stratum of the population. The study employed Independent t-test as a statistical tool. The results of the analysis showed that Perception of print resources has a significant influence on utilization of library resources; Perception of e-resources has a significant influence on utilization of library resources; Perception of audiovisual resources has a significant influence on utilization of library resources; Perception of reference resources has a significant influence on utilization of library resources. Based on the findings of this study the following recommendations were made. Management in collaboration with government should make sure required textbooks and print information resources are well stocked in the shelves of libraries so that students who are willing will make use of these print resources to improve on their studies.

Keywords: perception of library resources, utilization, perception of print resources, perception of e-resources, perception of audiovisual resource, perception of reference resources

1. Introduction

In an academic community library users need information for making vital and relevant decisions. Obviously, they may acquire information resources through the means of visiting the library for academic activities such as assignments, test, term paper, recreation, or research work which entails the process of finding idea, facts, and new information by scientific and systematic study. Hence, the library then serves as a vital and important channel where information is acquired, processed and disseminated through the provision of appropriate information resources in its various formats. Library is the bedrock of academic excellence in our society today. However, within many professions, associations, and organizations etc. are known to store and disseminate information, but the most important system that is efficient to this respect is the library. Traditionally, the library is a service and information centre where the sum total or even most human civilization and developments in prints and non-prints media are stored and organized systematically for the use of all the citizens in the course of their quest for information, knowledge, learning, teaching, research, recreation and entertainment (Ijatuyi & Adebayo, 2006). Therefore, libraries are critical to tertiary institutions.

Tertiary institutions are essential agents in the development of human resources of any nation. The foremost role

of tertiary institutions as defined in the Nigeria National Policy on Education (NPE) is the provision of middle and high-level manpower for national development which is realized through learning, teaching, research and community services. Therefore, the most potent and effective way of developing human resources is through education. This is why tertiary institutions places premium on the implementation of the National Policy on Education. National Policy on Education (2004) emphasizes providing basic tools for further educational advancement. Also to inculcate permanent literacy and numeracy on the ability to communicate effectively with printed and non-print information resources. (Etim & Nssien 2007). This crucial role of tertiary institutions cannot be achieved without the availability and accessibility of library resources in the libraries. Most importantly, the library is a vital resources centre for knowledge acquisition and learning. In any educational system, especially at the tertiary level, the volumes of academic works students have to do are usually reading centered which implies extensive use of library resources therein. Madu (2000) defined audiovisual as a machinery or hardware of education or a highly structured approach to teach like programmed learning. They includes: Audio CD and CD-ROM, Television, Radio, Audio tapes/cassette, Slides Telephone, Compact disc, Graphics/Photographic etc.

Academic libraries normally provide for educational needs of students, to support the academic staff in their teaching role and provide for research activities of both the students and academic staff. Similarly, the libraries are to generate new knowledge and also encourage transferred and adopted of new innovation — such as providing more relevant prints resources, e-resources, audio visual, and current reference sources for users. Since our tertiary institutions require an atmosphere of research activities. As such, their collections must reflect the subject interests of the institutions. It must also be adequate in terms of quality, quantity and variety. The library does this through useful selection and acquisition of materials for teaching, learning and research; process and organize the materials for easy retrieval, and dissemination of information about the collections and encourages their active exploitation (Hameed & Osunrinade, 2010; Edem & Ofre, 2008).

The ultimate aim of all libraries as a service-oriented organization is to satisfy the needs of its clients. Thus, users' satisfaction with the information resources, facilities and service provided by the library has become a focal point of the present-day librarianship and information science. Information utilization varies in relation to subject fields of the user, educational background, amount of experience and functions performed (Ogunsola, 2004). To utilize means to make use of something or to find a practical or effective use for something while use on its part means to put something into action or service for some purpose (Microsoft Encarta, 2009). Therefore, utilization of library resources simply means using library resources or putting library resources into use by library users. Orgem (2012) defines a library user as "a person who uses one or more library services at least a year". Hence, people who go to any type of library ranging from national, public, private, special, school to academic: intentionally or otherwise, requiring the attention of any library staff, or library resource, are termed library users.

Gyasi, Lamptey and Frempong (2009), observe similarly in Ghana that nowadays, the position of an academic library in a typical African university is gradually being threatened by the dwindling utilization of its resources by students. Even though tertiary institution libraries have historically stood the test of time, by having offered significant role in sustaining research, teaching and learning in all areas of specialization or fields of study in various institutions of higher learning across the globe, there is seemingly a sea change in relationships between tertiary institution students and use of academic library resources and services in the last few years (Lawal, Nkereuwem & Edem, 2008). Based on this, the researcher decided to investigate the perception of library resources and utilization among tertiary institutions students in Akwa Ibom State, Nigeria.

2. Theoretical Framework

2.1 Demand Theory

The demand theory was propounded by Lionel McClovin in 1925. This theory states that libraries should acquire only those information resources that are demanded or that will meet the demands of the community where the library is situated. McClovin believed strongly that academic libraries were established in response to academic demand. As such, it was the duty of librarians to provide the services required by the academic community. His belief was that the library should ascertain the needs of the people and then satisfy them. McClovin realized that the users' idea of what is important and valuable did not always coincide with that of the librarian. Therefore, he sought to balance these two factors by assigning numerical value to various subjects (according to their importance) and other numerical values based on the number of requests for book on a particular subject. These two numbers would then be multiplied to obtain a representative number.

The proponents of demand theory justify their stance by the belief that libraries have no right to impose their choice on others and decide what others should read since they are not all knowing. To this group, librarians should provide just what the clientele want irrespective of whether they are of high quality or not since they are the ones indirectly paying for them. This is in line with S. R. Ranganathan's five laws of library and information

science (1931). These laws made it imperative for everybody to have access to library collections. Based on the laws, librarians acknowledged the individuality of reading and uniqueness of information seeking habits of library users. Thirion and Pochet (2009) cited three studies which have demonstrated that going to a library or even having a library in a school clearly influences the students' school results.

3. Literature Review

3.1 Perception of Print Resources and Their Utilization

Successful educational system depends exhaustively on the accessibility and utilization of information sources and services. In this regard, academic libraries provide knowledge and information resources for teaching, learning and research. Academic libraries are rapidly supporting, encouraging and adapting new forms of teaching and learning exercises (Edward & Fisher, 2002). Information use is strongly related to an individual's ability to take risks, to make rational decisions and to achieve successful results. To get the right information to the right user at the right time, the information control process of information delivery system must have access to both appropriate information resources and appropriate information solution. The system must be able to select from all relevant information resources or that particular subset that solves the particular need of the user.

In a study by Oyewusi and Oyeboade (2009) at Ladoke Akintola University, Ogbomosa, Nigeria on the accessibility and use of library resources by undergraduates. A questionnaire was distributed among 600 students in the university, out of which, 393 were found appropriate for data analysis and conclusion. The respondents were asked to indicate the reasons for using the library. In the response, it was found that 76.8% respondents use the library as a place where they can read and study, 7.9% used it for research, 4.3% visit the library when they want to borrow a book, while 7.4% sleep and socialize in the library. Results indicated that Nigerian students have a positive perception about library as a place where serious academic work can be done. The study by Oyewusi and Oyeboade (2009) further showed that 297(75.6%) of the undergraduate students search for information in books and journals while 79(20.12%) searches for information through the internet. The result of the study also revealed that 5(1.3%) respondents consulted electronic books, 7(1.8%) electronic journals and 3(.8%) databases. This result implies that books and journals were more consulted sources of information by students as a result of their positive perception about these particular sources of information in their respective libraries.

According to Adeoye and Popoola (2011) for effective learning process, learners must have access to necessary information materials and resources. These resources might be in print or electronic format. They express that librarians are responsible for providing the right information to the right person at the right time. Regarding the accessibility of library resources, the authors added that the more accessible information sources require the least effort to access. Siu-Runyan (2011) added that higher quality school and public libraries correlate with higher scores on reading test done at the international level. School libraries are important source of books, when students have access to books, they read them, and when they read a lot, all aspects of literacy improved. Furthermore, books not only have positive effect on achievement but also that the positive impact of access is as large as the negative impact of poverty.

Mubashrah, Riaz-ul-Haq, and Shaziah (2013) in their study Library Resources: Utilization by Teachers and Students showed students' opinion regarding utilization of library resources. Maximum frequencies highlighted that all male and female students were aware about the availability of books in the library and they usually make maximum use of it i.e., 55 percent (60) male and 42 percent (50) female students responded that they did not visit library because there was no required material. It was further disclosed that the alternate resources of the library are used by those students which already marked that they do not use library. Maximum percentage showed that 44 percent (64) female and 35 percentage (08) male students use internet as an alternative resource of library. Students reported that insufficient resource material available in libraries related to the specific courses offered. Moreover, if some material was available, it was irrelevant, outdated and insufficient considering the number of students enrolled. Students suggested adding latest books, course specific books in number sufficient for enrolled students, ICTs i.e., computer systems, internet, photocopier, etc. to enhance the use of library.

Ani and Esin (2003) examined a feasible degree of library use as per the description of people in the academia. This was the case of five federal Nigerian universities. Questionnaire was used as the main instrument through which data was obtained while survey research design was adopted as methodology. In the end, the result of the research declared library sources in print form as sources which were least used. Meanwhile computers were rated as sources which were extensively used. However, an insignificant utilization of online sources was recorded. Furthermore, the research attested that the rate at which print format information sources in the surveyed universities was steadily on a sharp decline was alarming. It was concluded that information technology mostly the internet recorded a negligible use due to the fact that it (information technology) is a recent development especially in African university libraries and therefore provision of relevant information

technology infrastructure and training programmes in those universities in order for academics to have an improved and sustainable use of information technology in their universities' libraries were duly recommended (Ani & Esin, 2003).

In a study by Charles, Paul and Alfred (2013) on the use of academic libraries among students in tertiary institutions in Ghana, it was discovered that the most favourite library resources that undergraduates use are recommended textbooks and reference materials such as encyclopedias, dictionaries, maps, and atlases. Majority of the respondents (467 or 35.5%) indicated recommended textbooks as the most sought for resources when using the libraries. This also corroborates with the findings of Bature (2009) that the resources with direct bearing on course of study was the one mostly utilized by undergraduates in Kebbi State of Nigeria. The study showed that reference materials were the next material most students use at the libraries and this constitutes 30.4% (407) of the response.

Adebayo (2000) in Musa (2010) opined that the use of learning resources be it print, non-print, audiovisual enhance effective learning and contributes to the full potential of the learners. Effective utilization of these learning resources can only happen when students have a positive perception about these resources, and these will go a long way in helping in their tutorials, exercises and homework. Books have been called veritable vehicles of communication and transmission of education, learning and culture in any society. If undergraduates have a positive perception of library resources and are keen in utilizing same, there is no doubt that such students will perform excellently in their chosen fields of study. Akujuo (1991) in Musa (2010) has shown books as basic tools for educational development. Several research reports confirmed non-availability and underutilization of learning resources. Adesina (1990) revealed that higher institutions of learning in Nigeria are experiencing non-availability of core textbooks. Gojeh (1993) found out that college libraries have outdated and inadequate collections, while some programmes in the colleges do not have books, journals and reference materials to meet the need of patron. To come out of this trend, current and relevant learning resources must be made available and school administration and library authorities must mobilize students to effectively utilize the available library resources for better academic performance.

3.2 Perception of E-Resources and Their Utilization

As digital resources have increased exponentially over the last decade, academic libraries have heavily invested in electronic books, research databases, as well as electronic journals, and made them accessible via their library web portals. Some libraries also undertake usability initiatives to improve their web portals in order to provide users with better and easier access to their electronic collections and services. Despite these great efforts, it has been observed that instead of accessing a wealth of electronic content through the library web portal, students tend to rely on internet search engines (e.g., Google), and public web portals (e.g., Yahoo) even though scholarly information is not always readily available there (Low, 2003), and they often have difficulty distinguishing authoritative from non-authoritative information on the internet. As a result, underutilization of library electronic resources has become a common concern (e.g., Hong, Thong, Wong, & Tam, 2002; Thomsett-Scott & May, 2009).

Lee (2005) explained that latest information technology should be used to build library infrastructures, which includes upgraded intranet, extranet, and internet, and available software programs to facilitate the capture, analysis, organization, storage, and sharing of internal and external information resources for effective knowledge exchange among users, resources persons (faculty, researchers, and subjects specialists, etc.), publishers, government agencies, business and industries, and other organizations via multiple channels and layers. In recent years, many of the newly developed information technologies for database and information/document management can be utilized in knowledge management, such as, data warehousing, data mining, text mining, content management, knowledge extraction, knowledge mapping, groupware, and information visualization. Doosuur and Mwuese (2013) carried out a study on student's perception of library services in universities in Benue State. Their findings showed that 3.4% of respondents and 30.1% of the respondents in Benue State University (BSU) and Federal University of Agriculture (UAM) respectively agreed that ICT services are been offered in their libraries 60.4% and 31.1% agreed to the provision of reference services in their libraries. 11% and 15.6% agreed to library instruction been rendered in their libraries. 18% and 13.2% agreed that circulation services are rendered in their libraries. While 5.8% and 09.6 percent agreed to internet services offered to students of this library. Geisler, Giersch, McArthur and McClelland (2002) and Asamoah-Hassan (2011) believe that digital library helps its users in several ways.

Shalini and Rajyalakshmi (2008) in a study of user perceptions and utilization of library and information services of information centers in Nagpur City found out that majority 138 (53.48%) of respondents use internet daily. In a survey conducted by Anjuwon (2006) on 172 physicians at the University College Hospital (LCH) Ibadan, a 31-item, anonymous, standardized questionnaire was completed. Romanov, Kalie and Aarnio (2006) conducted a survey to evaluate medical and dental students' utilization of electronic information resources. A

web survey was sent to 837 students (49.9% respondents).

3.3 Perception of Audiovisual Resources and Their Utilization

In the findings of Schultz (2000) on the effects of graphical elements on perceived usefulness of a library web page, it was found that higher positive response to aesthetically designed pages contributes to how students perceive pages and ultimately how they choose or do not. This implies that effective utilization of audiovisual resources which include the multimedia on the internet will enhance high resources utilization, which invariably influences the desire of students' high academic performance. In a related study, Schenkman and Jonsson (2000) found that the ratio of illustration to text and beauty were related in determining preference and that a correlation existed between beauty and overall impression. This means that what someone sees and also hears gives a higher level of comprehension and understanding and can relate to high utilization of multimedia resources.

Audiovisual resources are the best library resources for users including undergraduates because it addresses more than one sense simultaneously, as it addresses the senses of sight and hearing. According to Aloraini (2005) it provides different stimuli in their utilization which includes texts, spoken words, sound and music, graphics, animations and pictures. All these elements when combined can result to effective utilization of library resources. In a study conducted by Beichner (1994) cited by Eno (2015) it was found that the utilization of multimedia has a positive effect on the knowledge and emotions of the students who study scientific subjects. Amen (1995) as cited by Eno (2015) also conducted another study on the impact of the hypermedia on the students' academic performance and their attitudes towards using the computer to teaching faculty of education students, Minya University. The study was conducted on 30 males and females students in the third grade in the faculty and they were represented into two groups; one was experimental and the other was the control group studied by traditional method. The study found statistically significant differences between the two groups concerning students' computer attitude scale in favour of the experimental group. Moreover, if found out statistically significant differences in the academic performance test between the two groups in favour of the experimental group. This implies that students who perceive audiovisual resources positively will make adequate utilization of it in their research work.

Yunis (2005) conducted a study on the effectiveness of multimedia software to study geometry in the second grade of preparatory schools aimed at identifying to what extent multimedia software helps in the academic achievement of the preparatory schools students in the subjects of both sex and its remembrance. A sample of 300 students of both sexes was used for the study. The experimental group was 150 while the control group was also 150 of both sexes. The experimental group used multimedia utilization while the control group was not exposed to multimedia utilization in their learning of geometry. The results revealed significant statistical differences in their average of academic achievement showing higher achievement in the experimental group. This in effect is an indication that when an enabling environment is provided for students, they will have a positive perception of multimedia resources which in turn will increase their utilization of these resources.

Similarly, Nasr (2005) studied the effectiveness of the use of multimedia computer technology on teaching geometry to the third preparatory grade students on their academic performance and the development of innovation thinking. Two groups were formed, experimental and control groups. The experimental group was exposed to utilization of multimedia in their study of a similar topic in geometry while the control group was not. The two groups were exposed to pre-text and a post-text achievement test. The results revealed that there are statistically significant differences between the average grades of the two groups at the level of academic performance. The experimental group that used the interactive multimedia performed better than the control group. The percentage the programme efficiency was 72 percent in developing students' positive perception of audiovisual resources. The efficiency degrees of the proposed programme were 60/70, which means that 72 percent of the students who utilized the multimedia got 60% or more of the final grade in geometry thinking test.

In a recent study by Aloraini (2012) on the impact of utilization of multimedia on students' academic achievement in the College of Education at King Saud University. The study aimed at finding out the impact of using multimedia on the female students' academic performance in the computer and its use in education. The study made use of equivalent groups, one experimental and one control consisting of 20 female students. The experimental group was introduced in the utilization of multimedia in their learning process while the control group was not allowed to use multimedia. Pretest as well as posttest was administered to the two groups. The results of the analysis of both the pretest and posttest revealed that there were statistically significant differences between the experimental group and the control group at a significant level of 0.05 in favour of the experimental group. This study also confirms many other results from studies like Watkins (1999), Abu (2005), Da'iij (2008), Nasr (2005), which shows significant difference among students' utilization of audiovisual resources. In the different results, those found to utilize audiovisual resources are those who perceived these resources positively and because they made use of these resources, their studies improved significantly.

There is also a large body of research that supports the influence of utilization of audiovisual resources on

students' academic performance through language acquisition (O'Hara & Pritchard, 2006; Pritchard & O'Hara, 2005; Leu, 2005; Cummins, 2005; Zhao, 2005). Numerous other studies demonstrate that students who utilize available multimedia and/or hypertext environments show greater gains in areas of language development than students who learn in more traditional environments. Zhao (2005) reviewed studies on influence of utilization of multimedia on language acquisition and came up with the following conclusions. Enhancing access efficiency through digital multimedia: multimedia presentations (video, images, text) can create stronger memory link than text alone. In addition, digital technologies allow instant playbacks, which provide learners with quick and easy access and different section of instructional materials than when they are using a textbook. Enhancing authentically using video and the internet: The internet provides learners with access to authentic materials like news and literature, while video can offer context rich linguistic and culturally relevant materials to learners. Furthermore, it has been discovered that students' perception of library resources goes a long way in determining how students utilize these resources. Boster' study (2004) of 2,500 sixth and eight grades students in Los Angeles that students who utilize multimedia resources and as a result of their positive perception of these resources had a statistically significant increase in mathematics performance scores.

3.4 Perception of Reference Resources and Their Utilization

According to Edem and Odu in Lawal, Nkereuwem and Edem (2008), these resources are documents that contain miscellaneous information on any topic be it on event, organization, individuals, government, subject area, and discipline. These resources, when there are available in the library may raise students' curiosity and thereby increase their utilization. Several scholarly journal articles in one field of specialization or research can now be accessed and there is no doubt that effective utilization of these invaLuab1e reference resources by both students and lecturers in the academic community will enhance high productivity and better academic performance (Ani & Ahiauzu, 2008).

In a study by Charles, Paul and Alfred (2013) on the use of academic libraries among students in tertiary institutions in Ghana, it was discovered that the most favourite library, resources that undergraduates use are recommended textbooks and reference materials such as encyclopedias, dictionaries, maps, and atlases. Majority of the respondents (467 or 35.5%) indicated recommended textbooks as the most sought for resources when using the libraries. This also corroborates with the findings of Balure (2009) that the resources with direct bearing on course of study was the one mostly utilized by undergraduates in Kebbi state of Nigeria. The study showed that reference materials were the next material most students use at the libraries and this constitutes 30.4% (407) of the response.

In a study by Shalini and Rajyalakshmi (2008) titled User Perceptions and Utilization of Library and Information Services of Information Centers in Nagpur City, it was revealed that 82,94% users are using reference services, 73.25% users know the periodical services provided followed by 49.32% of users aware about user orientation programme, 64.72% users are having awareness about reprographic services. 55.42% users are known about information services. Lending, reference and periodical services are more utilized by the user's community. All the 100°/b users are using lending services. Book reservation service is used by maximum (55.55%) users. Reference service is used by 92.85% of users. Maximum number of users 78.94% and 100% users used bibliographical services and reprography services respectively. 84.21% of users used newspaper clipping service. Periodicals are being used by 92 85% of users.

Momodu (2013) in his study "Library utilization among college of medicine research year undergraduates: Case study of Ambrose Alli University, Ekpoma Nigeria" revealed that though the research year undergraduates have library identification cards, they however, did not utilize reference resources for their research work. Toner (2005) conducted a study on the non-use of library reference sources by freshmen students. The researcher found out that libraries need to market their services better to the students that are not frequent visitors to the library. Marshall, Burns and Briden (2007) asserted that library instruction would help students perceive libraries as a credible resource. Students see faculty as the subject expert and interact with them almost every day. On the other hand, they view librarians as people who work in the library with whom they almost never interact. They do not think of librarians as subject experts, or even research experts, but only people managing library collections. Onifade, Ogbuiyi and Omeluzor (2013) in their study "Library resources and service utilization by postgraduate students in a Nigerian private University" observed that majority 36 (47 percent) of the respondents used reference sources occasionally while only 8 (10.5percent) of the respondents used the reference materials daily and 20 (26,34) respondents used the reference materials weekly followed by 7(9.2 Percent) used reference sources on a monthly basis.

4. Methodology

Ex-post -facto research design. The choice of the ex-post -facto design over other designs was basically due to the fact that the phenomena under study had already occurred. The population of this study consisted of 6,000 registered library users from five tertiary institutions in Akwa Ibom State, Nigeria. One thousand, seven hundred

and sixty registered library users from the University of Uyo, 660 registered library users from Akwa Ibom State University, 1,370 registered library users from Akwa Ibom State Polytechnic, 970 registered library users from the Maritime Academy of Nigeria and 1,240 registered library users from the College of Education, Afaha Nsit. The sample used a total of six hundred (600) respondents i.e., ten percent (10%) from each stratum of the population. Thereafter, 176 registered library users were sampled in the University of Uyo, 66 registered library users were sampled from the Akwa Ibom State University, 137 registered library users were sampled from Akwa Ibom State Polytechnic, 97 registered library users were sampled from the Maritime Academy of Nigeria, while 124 registered library users were sampled from the College of Education, Afaha Nsit. Their ages were between 16 and 36 years. The study employed independent t-test as a statistical tool.

5. Presentation of Results

5.1 Hypothesis One

Perception of print resources has no significant influence on students' utilization of library resources. The independent variable in this hypothesis is perception of print resources (classified into Negative and Positive perceptions), while the dependent variable is utilization of library resources (classified into print information resources, e-resources, audiovisual resources and reference resources), Scorers below the mean, on the perception of print resources scale, were classified as having negative perceptions; while those above the mean were classified as having positive perceptions. Subjects who scored exactly the mean were negligible in number so they were considered as having positive perceptions. Based on the two classifications of perception, independent t-test statistical technique was employed in testing the hypothesis.

Table 1. Summary of descriptive statistics for all continuous variables of the study

S/N	Variable	n	$\bar{X}$	SD
1.	Perception of print resources	600	13.08	3.61
2.	Perception of e-resources	600	15.51	3.48
3.	Perception of audiovisual resources	600	10.45	3.63
4.	Perception of reference resources	600	12.45	3.85
5.	Utilization of print resources	600	12.60	3.99
6.	Utilization of e-resources	600	11.24	4.09
7.	Utilization of audiovisual resources	600	8.59	3.78
8.	Utilization of reference resources	600	13.77	3.76
9.	Overall utilization of library resources	66	46.21	13.07

Table 2. Summary of independent t-test for the influence of students' perception of print resources on utilization of library resources

S/N	Variable	Perception	n	$\bar{X}$	SD	T
1.	Utilization of print resources	Negative	246	11.29	3.17	7.001*
		Positive	354	1352	4.24	
2.	Utilization of e-resources	Negative	246	9.20	3.23	11.186*
		Positive	354	12.66	4.02	
3.	Utilization of audiovisual resources	Negative	246	7.10	2.86	8.555*
		Positive	354	9.64	4.00	
4.	Utilization of reference resources	Negative	246	12.51	3.58	7.098*
		Positive	354	14.64	3.65	
5.	Overall utilization of library resources	Negative	246	40.10	9.70	10.350*
		Positive	354	50.45	13.44	

* significant at .05 level; df = 598; critical t=1.96.

Results of analysis showed that the calculated t-value for utilization of print resources (7.001), e-resources

(11.186), audiovisual resources (8.555), reference resources (7.098), and for overall utilization of library resources (10.350), are each greater than the critical t-value of 1.96 at .05 level of significance using 598 degrees of freedom. This means that students' perception of print resources significantly influence their utilization of library resources. The results show that it was students who had positive perception towards print resources that exhibited a higher utilization of library resources than their counterparts who had negative perception towards print resources.

5.2 Hypothesis Two

Perception of e-resources has no significant influence on students' utilization of library resources. The independent variable in this hypothesis is perception of e-resources (classified into Negative and Positive perceptions), while the dependent variable is utilization of library resources (classified into print information resources, c-resources, audovisua1 resources and reference resources). Scorers below the mean, on the perception of print resources scale, were c1assfied as having negative perceptions: while those above the mean were classified as having positive perceptions. Subjects who scored exactly the mean were negligible in number so they were considered as having positive perceptions. Based on the two classifications of perception, independent t-test statistical technique was employed in testing the hypothesis. The results of the analysis are presented in Table 2. Results of analysis show that the calculated t-value for utilization o prints - resources (11.502), e-resources (13.596), audiovisual resources (12.3,10), reference resources (l l.439), and for overall utilization of library resources.

Table 3. Summary of independent t-test for the influence of students' perception of e-resources on utilization of library resources

S/N	Variable	Perception	n	$\bar{X}$	SD	T
1.	Utilization of print resources	Negative	304	10.93	2.82	11.502*
		Positive	296	14.32	4.27	
2.	Utilization of e-resources	Negative	304	9.28	3.12	13.596*
		Positive	296	13.25	3.99	
3.	Utilization of audiovisual resources	Negative	304	6.92	2.17	12.310*
		Positive	296	10.32	4.28	
4.	Utilization of reference resources	Negative	304	12.20	3.41	11.439*
		Positive	296	15.39	3.42	
5.	Overall utilization of library resources	Negative	304	39.33	7.73	15.436*
		Positive	296	13.67	13.67	

* significant at .05 level; df = 598; critical t=1.96.

(15.436) are each greater than the critical t-value of 1.96 at .05 level of significance using 598 degree of freedom. This means that students' perception of e-resources significantly influences their utilization of library resources. The results show that it was students who had positive perception towards e-resources that exhibited a Results of analysis show that the calculated t-value for utilization of print resources (11.502), c-resources (13.596), audiovisual resources (12.3.10), reference resources (11.439), and for overall utilization of library resources (15.436) higher utilization of library resources than their counterparts who had negative perception towards c-resources.

5.3 Hypothesis Three

Perception of audiovisual resources has no significant influence on students' utilization of library resources.

The independent variable in this hypothesis is perception of audiovisual resources (classified into Negative and Positive perceptions), while the dependent variable is utilization of library resources (classified into print information resources, e-resources, audiovisual resources and reference resources). Scorers below the mean, on the perception of print resources scale, were classified as having negative perceptions while those above the mean were classified as having positive perceptions. Subjects who scored exactly the mean were negligible in number so they were considered, as having positive perceptions. Based on the two classifications of perception, independent t-test statistical technique was employed in testing the hypothesis.

Table 4. Summary of independent t-test for the influence of students' perception of audiovisual resources on utilization of library resources

S/N	Variable	Perception	n	$\bar{X}$	SD	t
1.	Utilization of print resources	Negative	442	11.49	3.38	12.991*
		Positive	158	15.73	3.89	
2.	Utilization of e-resources	Negative	442	9.95	322	15.151*
		Positive	158	14.84	4.10	
3.	Utilization of audiovisual resources	Negative	442	7.37	2.64	15.835*
		Positive	158	12.03	4.34	
4.	Utilization of reference resources	Negative	442	12.94	3.34	9.695*
		Positive	158	16.09	3.29	
5.	Overall utilization of library resources	Negative	442	41.75	9.72	17.012*
		Positive	158	58.68	13.19	

* significant at .05 level; df = 598; critical t=1.96.

Degrees of freedom. This means that students' perception of audiovisual resources significantly influence their utilization of library resources. The results show that it was students who had positive perception towards audiovisual resources that exhibited a higher utilization of library resources than their counterparts who had negative perception towards audiovisual resources.

5.4 Hypothesis Four

Perception of reference resources has no significant influence on students' utilization of library resources, the independent variable in this hypothesis is perception of reference resources (classified into Negative and Positive perceptions), while the dependent variable is utilization of library resources (classified into print information resources, e-resources, audiovisual resources and reference resources). Scorers below the mean, on the perception of print resources scale, were classified as having negative perceptions: while those above the mean were classified as having positive perceptions. Subjects who scored exactly the mean were negligible in number so they were considered as having positive perceptions. Based on the two classifications of perception, independent t-lest statistical technique was employed in testing the hypothesis.

Results of analysis show that the calculated t-value for utilization of print resources (7.953), e-resources (13.217), audiovisual resources (9.319), reference resources (8.121), and for overall utilization of library resources (11.872), are each greater than the critical t-value of 1.96 at .05 level of significance using 598 degrees of freedom, this means that students' perception of reference resources significantly influence their utilization of library resources. The results show that it was students who had positive perception towards reference resources that exhibited a higher utilization of library resources than their counterparts who had negative perception towards reference resources.

Table 5. Summary of independent t-test for the influence of students' perception of reference resources on utilization of library resources

S/N	Variable	Perception	n	$\bar{X}$	SD	t
1.	Utilization of print resources	Negative	198	10.85	2.68	7.953*
		Positive	402	13.47	4.23	
2.	Utilization of e-resources	Negative	198	8.47	2.97	13.217*
		Positive	402	12.60	3.87	
3.	Utilization of audiovisual resources	Negative	198	6.68	2.13	9.319*
		Positive	402	9.54	4.05	
4.	Utilization of reference resources	Negative	198	12.08	3.55	8.121*
		Positive	402	14.60	3.59	
5.	Overall utilization of library resources	Negative	198	38.08	7.30	11.872*

		Positive	402	50.21	13.43	

* significant at .05 level; df = 598; critical t=1.96.

6. Summary of the Study

The study was designed to determine the perception of library resources and utilization among tertiary institution students in Akwa Ibom State, Nigeria. To this end, the study specifically sought to establish the influence of print resources, e-resources, audiovisual resources and reference resources on utilization of library resources. The results of the analysis showed that:

1) Perception of print resources has a significant influence on utilization of library resources.
2) Perception of e-resources has a significant influence on utilization of library resources.
3) Perception of audiovisual resources has a significant influence on utilization of library resources.
4) Perception of reference resources has a significant influence on utilization of library resources.

7. Conclusion

Four major hypotheses were tested in the course of this study. On the basis of the findings, it was concluded that print resources, e-resources, audiovisual resources and reference resources significantly influenced utilization of library resources. This implies that students who perceived library resources positively made better use of library resources.

8. Recommendations

Based on the findings of this study the following recommendations were made.

1) Management in collaboration with government should make sure required textbooks and print information resources are well stocked in the shelves of libraries so that students who are willing will make use of these print resources to improve on their studies.
2) Librarians should show more interest in the development of information and communication technology (ICT), and internet services should be improved in the study area. The government should make available computers with robust internet connectivity to students for their research work.
3) Librarians should engage in professional retooling by integrating learning into work and also apply what they learn daily for effective services delivery, there is the need to acquire new skills and competencies that could change the shape and scope of library services to readers, this could boost their interest in using information resources maximally.
4) The libraries should re-order her priorities through a major policy shift in order to provide level ground for the provision of current information resources and tools. By these librarians will be able to face squarely the challenge of adequate and effective library service delivery to users in the study.

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Theoretical Framework and Practical Pathways for International Talent Training in Educational Informatization from the Perspective of "Industry-University-Research-Application" Synergy

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Abstract

This paper focuses on the core contradiction of the global educational informatization industry: the rapid iteration of technology and the shortage of composite talents. According to the *Global Educational Technology Talent Development Report 2023*, China faces a gap of over 300,000 professionals who are proficient in technology, understand international rules, and are skilled in cross-cultural collaboration. The existing talent training model, which relies solely on universities, suffers from issues such as the disconnection between theory and industry (with less than 20% corporate participation in talent training) and weak international collaboration (with overseas practice coverage below 15%). These shortcomings make it difficult to meet the demands of the "Belt and Road" educational initiatives. Based on stakeholder theory and collaborative governance theory, this paper constructs a quadruple synergy system involving universities, international enterprises, research institutions, and overseas application scenarios. Through literature research, the Delphi method (three rounds of argumentation with 15 experts), and case analysis (three typical cases), this paper clarifies the logic of quadruple synergy and sets three-dimensional capability objectives: technology research and development, cross-cultural project operation, and international rule adaptation. It also designs a full-chain pathway of "curriculum co-construction – overseas practice – achievement transformation". The results show that this system can increase students' participation rate in international projects by 40% and improve their cross-cultural operation capability scores by 35%. This study is the first to incorporate overseas application scenarios into the "industry-university-research-application" framework, filling the gap in international talent capability standards for educational informatization and providing references for policy-making, university practices, and corporate initiatives.

Keywords: educational informatization, international talent training, industry-university-research-application synergy, collaborative governance, cross-cultural capability, quadruple synergy, overseas practice bases, technology research and development capability, international rule adaptation capability, belt and road educational initiatives, educational technology solutions going global

1. Introduction

1.1 Research Background

The global educational informatization industry is facing the prominent contradiction between the acceleration of technological iteration and the insufficient supply of composite international talents. The *Global Educational Technology Talent Development Report 2023* indicates that China lacks over 300,000 professionals who possess technological capabilities (Qi, Z., 2025), knowledge of international rules, and cross-cultural collaboration skills. This gap has become a key bottleneck for the internationalization of Chinese educational technology solutions. The existing talent training model, which overly relies on universities as the sole entity, has two core issues: first,

the disconnection between theoretical teaching and industry demand, with less than 20% corporate participation in talent training and curriculum content that fails to match international industry practices (such as cross-border educational AI application standards); second, insufficient depth in international collaboration, with overseas practice scenario coverage below 15% and students lacking practical experience in cross-cultural project operation and international rule adaptation. Against this backdrop, constructing an "industry-university-research-application" synergy-based talent training system for educational informatization has become an inevitable choice to meet the demands of the "Belt and Road" educational initiatives and to break through the talent dilemma.

1.2 Research Significance

1.2.1 Theoretical Significance

This study breaks through the theoretical limitations of the traditional "university – enterprise – research institution" tripartite synergy by incorporating "overseas application scenarios" into the "industry-university-research-application" framework, enriching the collaborative theoretical system for international talent training in educational informatization. It constructs a three-dimensional capability indicator system of "technology + cross-culture + international rules," filling the theoretical gap in international talent capability standards in this field.

1.2.2 Practical Significance

This study provides an operational path for collaborative cooperation among universities, international educational technology enterprises, research institutions, and overseas practice bases, solving the problem of "disconnection between theoretical teaching and industrial practice." It also offers data support for educational administrative departments to formulate "policies for international talent training in educational informatization," contributing to the talent reserve construction for the internationalization of Chinese educational technology solutions.

1.3 Literature Review

In domestic research, "industry-university-research-application synergy" mostly focuses on traditional manufacturing or local talent training, with few studies involving "international talents" and "overseas scenarios." Research on "talent training in educational informatization" tends to emphasize technical capabilities (such as educational AI and big data) while neglecting international attributes like cross-cultural collaboration, and there is a lack of case analysis on multi-entity collaboration. International research (taking the US and Europe as examples) emphasizes bilateral collaboration between universities and enterprises (such as the joint courses on educational technology offered by Stanford University and Google), but with low participation from research institutions and overseas scenarios, and a focus on serving local industries rather than designing cross-cultural training paths for non-local scenarios. Existing studies have not yet formed a "quadruple synergy" theoretical framework, lack systematic design for "overseas implementation practice," and have not established a unified set of international talent capability indicators. This study addresses these gaps. (Li, W., 2025)

2. Theoretical Foundations

2.1 Definition of Core Concepts

2.1.1 "Industry-University-Research-Application" Synergy

This refers to the collaboration model among universities (theoretical teaching), international enterprises (industry demand), research institutions (technological breakthroughs), and overseas application scenarios (implementation verification). Based on common interests, these four parties achieve a closed loop of "training – practice – implementation" for international talents in educational informatization through resource sharing, division of responsibilities, and mechanism guarantees.

2.1.2 International Talents in Educational Informatization

These are composite talents who possess technological research and development capabilities (educational AI, data security), cross-cultural project operation capabilities (multilingual communication, local demand adaptation), and international rule adaptation capabilities (educational technology regulations, intellectual property rights). They are capable of serving transnational educational informatization projects or the internationalization of Chinese educational technology solutions.

2.2 Supporting Theories

2.2.1 Stakeholder Theory

This theory posits that organizational development requires balancing the needs of all stakeholders. In this study, universities seek to improve talent training quality, enterprises aim for talent suitability, research institutions pursue technological transformation, and overseas scenarios focus on project implementation effectiveness. The

balance of these four parties' needs is the foundation for the effective operation of the collaborative system and provides theoretical support for defining responsibilities and allocating interests.

2.2.2 Collaborative Governance Theory

This theory emphasizes that multiple entities achieve public goals through interactive collaboration. Its core concepts of "multi-party participation, resource integration, and mechanism guarantee" support the design of the collaborative process (such as curriculum co-construction) and safeguard mechanisms (such as credit recognition) in the quadruple synergy. This ensures the orderly progress of the collaborative process.

2.3 Theoretical Applicability Analysis

Stakeholder theory addresses the question of "why the four parties collaborate," clarifying the demands and collaborative motivations of each entity. Collaborative governance theory addresses "how the four parties collaborate," guiding the design of the collaborative process and mechanisms. Together, these two theories form the theoretical cornerstone of the "industry-university-research-application" synergy system, effectively supporting the construction of the talent training closed loop.

3. Theoretical Framework Construction of "Industry-University-Research-Application" Synergy

3.1 Definition of Responsibilities of the Four Parties

Universities, as the core of theoretical teaching, are responsible for building a "basic theory + international vision" curriculum module. They should thoroughly cover courses such as International Educational Technology Regulations and integrate resources from enterprises and research institutions for joint teaching. They also assess students and convert overseas practice into credits. International enterprises, closely following industry trends, translate the latest demands, such as the cross-cultural adaptation of educational AI, into key points for courses. They send corporate mentors to guide students in technical practice and project operation and provide multinational internship positions to seamlessly connect talent supply with overseas demand. Research institutions directly incorporate cutting-edge results, such as educational AI algorithms and intelligent assessment, into the classroom. They enable students to participate in real technical breakthroughs, such as optimizing the performance of educational platforms, and help enterprises implement technology in overseas scenarios. Overseas application scenarios offer real projects, such as the construction of smart campuses in Southeast Asia, as a testing ground. They guide students in conducting cross-cultural demand research and provide real-time feedback on project implementation, using practical data to profile talent capabilities.

3.2 Three-Dimensional Capability Training Objectives

The three-dimensional capabilities are integrated as follows: Technological research and development capability forms the foundation. Students must master the basics of educational AI and big data analysis, optimize algorithms for low-end hardware in overseas settings, and incorporate international data regulations like GDPR into their code. Cross-cultural project operation capability serves as the bridge. It starts with multilingual negotiation but more importantly involves understanding local education policies and instantly translating them into product requirements. Using the PMBOK international standard, students manage multinational teams, remote nodes, and time-zone meetings smoothly. International rule adaptation capability acts as a safety lock. Students break down international regulations such as the US Children's Online Privacy Protection Act, EU copyright directives, and ISO educational technology standards into actionable checklists. They preemptively avoid intellectual property pitfalls and compliance traps, ensuring smooth project implementation in the global market.

3.3 Theoretical Model Construction

A "quadruple drive – three-dimensional capabilities – closed-loop iteration" model is constructed. The "quadruple drive" is centered on the four parties, promoting collaboration through resource sharing. The "three-dimensional capabilities" run through the entire training process, clarifying the core objectives of talent training. The "closed-loop iteration" involves a cycle of "theoretical teaching → technical practice → overseas implementation → feedback optimization," continuously improving courses and practice plans to dynamically enhance training quality.

4. Practical Pathway Design

4.1 Curriculum Co-Construction: Theoretical Teaching Collaboration

Aiming to solve the problem of "disconnection between theory and industry," the four parties collaborate on curriculum construction. Universities, in conjunction with enterprises and overseas scenarios, first conduct talent demand surveys. They then jointly design curriculum modules (for example, International Educational Data Security Regulations is co-constructed by universities and enterprises, while Cross-cultural Educational Project Management is co-constructed by universities and overseas scenarios). A "blended" teaching approach

combining online and offline methods is adopted, with university teachers covering theory and experts from enterprises, research institutions, and overseas scenarios presenting case studies. Finally, the four parties jointly assess the effectiveness of the courses and optimize the content.

4.2 Technological Breakthroughs: Research Practice Collaboration

A "topic docking – mentor guidance – achievement transformation" model is adopted: Research institutions release technical breakthrough topics (such as "multilingual educational resource recommendation algorithms"), with enterprises and overseas scenarios proposing demands; universities select students to form teams, equipped with "university + enterprise + research" tripartite mentors; students conduct research under the guidance of mentors, regularly reporting progress; research institutions and enterprises promote the patenting and productization of results, with students participating in the transformation process to enhance their technological innovation capabilities.

4.3 Overseas Implementation: Application Verification Collaboration

Three types of overseas practice bases are relied upon to advance this process: First, joint training bases (such as those built with Khan Academy in the US for 1-2 months of technical training); second, project internship bases (such as international schools in Southeast Asia for 3-6 months of smart campus construction internships) (Haoyang Huang, 2025); and third, special practice projects (such as supporting global educational technology forum technical support in collaboration with the International Educational Informatization Association). The practice process includes pre-job training (on culture and policies), project participation (from demand research to implementation), process guidance (a combination of online and offline), and practice assessment (joint scoring by the four parties).

4.4 Safeguard Mechanisms

Universities convert corporate training, research breakthroughs, and overseas practice into credits. One month of overseas internship can be exchanged for two credits, ensuring uninterrupted training schedules. After technological results are transformed, the revenue is distributed in cash as follows: research institutions receive 40%, enterprises receive 30%, universities receive 20%, and students receive 10% (Xiaoying Yang, 2025), incentivizing both the laboratory and students. The four parties hold a fixed monthly online "check-in" to align progress and address issues, with each party designating a daily contact person for immediate information exchange.

Table 1.

Dimension	**Specific Practices**
Credit Conversion	Enterprise training, scientific research, and overseas practice can be converted into credits.
Profit Sharing	Cash is distributed upon the transformation of technological achievements.
Progress Alignment	Monthly fixed online "check-ins."
Daily Communication	Each party designates one "on-call" contact person.
Training Pace	Continuous and uninterrupted course scheduling.

5. Case Validation

5.1 Case Selection and Data Collection

Three typical cases were selected: Case 1 is the "China-US Joint Training Base" (university + enterprise bilateral collaboration), Case 2 is the "Southeast Asia Educational Technology Internship Project" (university + enterprise + overseas scenario trilateral collaboration), and Case 3 is the "International Educational Informatization Association Special Program" (quadruple collaboration involving universities, enterprises, governments, and NGOs). Information was collected through interviews (with 50 students, 20 corporate mentors, and 15 overseas managers), questionnaires (300 valid questionnaires) (Zhong, Y., 2025), and data statistics (project participation rates and capability scores). The Cronbach's α coefficient of the questionnaire was 0.86, indicating reliable data.

Table 2.

Case Name	**Collaborative Entities and Model**
China-US Joint Training Base	University + Enterprise (Bilateral Collaboration)

Southeast Asia Education and Technology Internship Program	University + Enterprise + Overseas Context (Trilateral Collaboration)
International Education Informationization Association Special Program	University + Enterprise + Government + NGO (Quadrilateral Collaboration)

5.2 Comparative Efficacy and Problem Diagnosis of Typical Cases

The China-US Joint Training Base (2 months), focusing solely on educational AI, achieved a 28% increase in students' technological research and development capabilities through university-enterprise bilateral collaboration. However, due to the absence of research institutions and overseas scenarios, cross-cultural operation capabilities only increased by 12%, and there was no significant change in international rule adaptation capabilities. This exposed the problem of "technological advancement at the expense of international attributes." In contrast, the Southeast Asia Educational Technology Internship Project (4 months), involving trilateral collaboration among universities, enterprises, and overseas primary and secondary schools, saw a 32% increase in cross-cultural operation capabilities and maintained an 85% project participation rate. However, the lack of in-depth guidance from research institutions resulted in only an 18% increase in technological research and development capabilities, leading to a "strong in culture, weak in technology" dilemma. The true breakthrough came with the International Educational Informatization Association Special Program (6 months), which involved quadruple collaboration among governments, universities, enterprises, and NGOs. This program covered all three modules — technology, culture, and rules — with a full-chain approach of "theory – research – practice – implementation." Backed by research institutions' cutting-edge algorithm research, technological research and development capabilities increased by 35%. The joint development of compliance processes by overseas schools and government education departments led to a 30% increase in international rule adaptation capabilities for the first time. NGOs and communities continuously created cross-cultural contexts, further boosting cross-cultural operation capabilities by 38%. With multiple entities sharing risks and resources, the project participation rate reached 92%, and all three capabilities were enhanced without significant weaknesses. This validated the collaborative logic that "the more diverse the scenarios and the more complete the chain, the more balanced the capability improvement."

Table 3.

Case Name	**Improvement in Technology R&D Capability**	**Improvement in Cross-Cultural Operation Capability**
China-US Joint Training Base	28%	12%
Southeast Asia Education and Technology Internship Program	18%	32%
International Education Informationization Association Special Program	35%	38%

5.3 Optimization Strategies

First, strengthen the participation of weaker parties by establishing mandatory participation mechanisms for research institutions and overseas scenarios to avoid "formalistic collaboration." Second, unify capability assessment standards by developing the Educational Informatization International Talent Capability Assessment Manual. Third, improve the profit-sharing mechanism by increasing the students' share of revenue to 15% when their project participation rate reaches 50%, thereby enhancing their enthusiasm.

6. Innovations

6.1 Theoretical Innovation: Expanding the Boundaries of Collaborative Entities

For the first time, this study incorporates "overseas application scenarios" into the "industry-university-research-application" system, breaking through the limitations of the traditional tripartite collaboration. It forms a closed loop of "training – practice – implementation," addressing the traditional theory's issue of "emphasizing training while neglecting implementation" and enriching the connotation of collaborative theory.

6.2 Pathway Innovation: Designing a Full-Chain Collaborative Pathway

A full-chain collaborative pathway of "international curriculum co-construction + overseas project practice + joint transformation of technological achievements" is constructed, covering the entire process of "theory –

research – practice – implementation." This addresses the problems of "disconnection between theory and practice" and "disconnection between research and application," achieving collaborative talent training throughout the entire process.

6.3 Indicator Innovation: Establishing a Three-Dimensional Capability System

Focusing on the "international attributes" of educational informatization international talents, a three-dimensional indicator system of "technological research and development + cross-cultural operation + international rule adaptation" is established. This fills the gap in existing research that "emphasizes technology while neglecting international attributes," providing a unified standard for talent training and assessment.

7. Conclusions and Future Work

7.1 Main Conclusions

First, the quadruple synergy theoretical framework is clarified: universities as the core of theoretical teaching, enterprises as the guide of industry demand, research institutions as the support of technological breakthroughs, and overseas scenarios as the carrier of implementation. Among the three-dimensional capabilities, technological research and development is the foundation, cross-cultural operation is the core, and international rule adaptation is the safeguard. Second, the effectiveness of the practical pathways is verified: the quadruple collaboration pathway yields the best results, with students' three-dimensional capabilities increasing by 30%-38%. In contrast, bilateral and trilateral pathways suffer from one-sided capability training issues. Third, policy recommendations are proposed: educational administrative departments should establish special funds and unified assessment standards; universities should optimize their curriculum and credit systems; enterprises and research institutions should deepen collaboration; and overseas scenarios should improve the construction of practice bases.

7.2 Limitations and Future Research

The limitations lie in the insufficient regional coverage of the case studies (lacking examples from Europe, America, and South America) and the short-term data collection (only six months), with no long-term tracking. Future work could expand the case study regions, conduct 1-2 years of long-term tracking research, and explore AI-driven digital platforms for quadruple collaboration to enhance collaborative efficiency.

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The Enriched Twin: An Updated Ethical-Pedagogical Framework for K-12 Digital Heritage Education in the Agentic AI Era

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Abstract

The rapid evolution of agentic artificial intelligence (Agentic AI) and digital twin technologies has profoundly transformed cultural heritage preservation and education. These tools enable immersive, interactive reconstructions of historical sites and artifacts, fostering deeper engagement with the past. However, they also pose significant risks, including the amplification of biases, perpetuation of colonial narratives, and erosion of community data sovereignty if applied without critical oversight. This updated framework revisits the 'Enriched Twin' project-based learning (PBL) program within a STEAM (Science, Technology, Engineering, Arts, and Mathematics) context, incorporating advancements in Agentic AI from 2024–2025. It interweaves three core conceptual threads: (1) the progression from static digital twins to semantically enriched, Agentic AI-augmented knowledge ecosystems; (2) a critical hermeneutics of AI, scrutinizing Agentic AI's dual capacity as an analytical instrument and a propagator of cognitive biases; and (3) decolonizing methodologies that prioritize community data sovereignty and ethical co-creation. Practical modules encompass drone-based data capture and Agentic AI-assisted 3D modeling, culminating in collaborative development of 'enriched' digital twins for local heritage sites. This model cultivates technical proficiency alongside digital literacy, critical judgment, and ethical responsibility, aligning with UNESCO's 2021 Recommendation on the Ethics of Artificial Intelligence and recent Agentic AI guidelines for education (UNESCO, 2025a). By embedding these principles, the framework extends beyond technical instruction to promote holistic development, preparing K-12 students as responsible digital stewards. Future research trajectories include cognitive-affective evaluations, design-based iterations, and action research on community partnerships to validate and refine this approach for broader applicability in digital humanities education.

Keywords: agentic AI, digital twin, cultural heritage, K-12 education, curriculum design, digital humanities, decolonizing methodology, project-based learning, STEAM, AI ethics

1. Introduction

The integration of agentic AI (Agentic AI) and digital twin technologies into cultural heritage education represents a paradigm shift, offering transformative opportunities for K-12 learners. Students can now digitally reconstruct ancient ruins, simulate environmental impacts on artifacts, and generate interactive narratives that bring history to life. For instance, Agentic AI tools allow for real-time analysis of vast cultural datasets, enabling personalized learning experiences (UNESCO, 2025b). However, this technological frontier is fraught with ethical challenges. Data sources often stem from colonial archives, and Agentic AI algorithms, trained on biased corpora, can perpetuate societal prejudices, presenting a 'technologized version of a single, dominant story' (Noble, 2018; Manalikul, 2023).

Recent developments underscore these concerns. UNESCO's 2025 expert report on AI and culture emphasizes the need for 'cultural-AI literacy' that balances technical skills with critical thinking (UNESCO, 2025b). Similarly, studies on Agentic AI in heritage preservation demonstrate enhanced interactivity but warn of cultural

misrepresentation risks (npj Heritage Science, 2025). The emergence of agentic AI—autonomous systems that plan, act, and learn independently—further complicates this landscape. Agentic AI extends traditional AI by enabling proactive interventions, such as real-time bias detection in heritage narratives or adaptive community collaborations, but raises new concerns about accountability and over-automation in educational settings (Jones, 2025; Cunningham-Nelson et al., 2019). In response, this article presents an updated 'Enriched Twin' framework for K-12 education. Rooted in PBL and STEAM, it trains students not only in digital production but also in critical reflection on AI's implications. The paper is structured as follows: a conceptual framework, pedagogical design including skill modules and capstone, ethical integration strategies, and directions for empirical validation.

2. Conceptual Framework

The curriculum is anchored in three interconnected pillars, refreshed with 2025 insights on Agentic AI and decolonization.

2.1 The Semantic Digital Twin: From Replica to Agentic AI-Augmented Knowledge Ecosystem

Digital twins in cultural heritage have advanced from static 3D replicas to dynamic ecosystems enriched by IoT sensors and Agentic AI (Bruno et al., 2019; Gavrilov et al., 2021). Recent innovations include AI-powered 'living' digital twins for historical sites, enabling predictive conservation and immersive experiences (Mixflow.AI, 2025). Agentic AI enhances semantic annotations and hypothetical reconstructions, as seen in AI-assisted analysis of ancient manuscripts (Jones, 2020). This evolution enables inquiry-driven learning, shifting from passive viewing to active exploration. Students can query correlations between structural weaknesses and climate data projections, fostering STEAM integration.

2.2 AI-Augmented Hermeneutics: Navigating Cultural Narratives with Agentic AI

Agentic AI's analytical prowess revolutionizes cultural studies, but its biases demand scrutiny (Kaplan & Haenlein, 2019; Noble, 2018). Studies show Agentic AI favoring Western perspectives in heritage contexts (Manalikul, 2023). The framework employs 'critical AI-assisted hermeneutics': students use Agentic AI for initial interpretations, then deconstruct outputs for biases, cross-referencing with community sources. This aligns with initiatives on AI literacy in museums (Sineglossa, 2025). Extending this to agentic AI, which operates autonomously to achieve objectives with minimal supervision (Jones, 2025), introduces proactive hermeneutics. Agentic systems can independently monitor digital twin interactions for emerging biases, suggest alternative narratives, or facilitate real-time community feedback loops, enhancing critical engagement while requiring safeguards against unintended autonomy in educational tools (Cunningham-Nelson et al., 2019; Xie et al., 2024).

2.3 Decolonizing the Digital Archive: Ethical Imperatives and Sovereignty

Digitizing heritage risks replicating colonial power dynamics (Christen, 2012). Recent scholarship advocates Indigenous Data Sovereignty (First Nations Information Governance Centre, 2014; Tiribelli & Mhlambi, 2023). A 2025 study uses NLP to expose biases in colonial records (Cambridge University Press, 2025). The framework mandates community co-creation, data sovereignty agreements, and platforms like Mukurtu CMS (Christen, 2015). By interrogating representation at every stage, it disrupts biased AI-training loops (Das & Lally, 2021; Lally, 2022). Agentic AI can support decolonization by autonomously curating diverse sources and flagging colonial legacies, but must be programmed with ethical overrides to ensure community control (Walsh et al., 2023).

2.4 Weaving Ethics into the Workflow: Challenges and Mitigation Strategies

Ethical risks include cultural misrepresentation, algorithmic bias, and privacy breaches. Mitigation incorporates Traditional Knowledge Labels and Principles of Seville (Bentkowska-Kafel, 2015). Algorithmic bias is addressed through bias statements on Agentic AI outputs (ResearchGate, 2025). Privacy in drone operations follows FAA guidelines and consent protocols (Finn & Wright, 2016). These strategies embed ethics into workflows, fostering internalized awareness among students. For agentic AI, additional mitigations include transparent audit trails and 'human-in-the-loop' requirements to prevent autonomous decisions from overriding ethical considerations (Xie et al., 2024).

3. Proposed Curriculum: The Enriched Twin Framework

A PBL-STEAM structure centers on creating enriched digital twins (Larmer et al., 2021; Liao, 2016).

3.1 Module 1: The Drone as an Ethical Data-Gathering Tool

Students master drone piloting for photogrammetry and LiDAR, drawing from established curricula. Ethical training covers privacy and surveillance, operationalizing AI's 'Perception' idea (AI for K-12 Working Group, 2021). Assessments require community consent plans.

3.2 Module 2: Agentic AI-Augmented 3D Modeling for Reconstruction and Narrative

Using tools like MeshLab, students process data into models, then augment with Agentic AI for annotations and bias analysis (Cignoni et al., 2008). This transforms models into multi-layered narratives, addressing societal impacts. Incorporating agentic AI, students deploy simple agents to autonomously scan models for bias indicators or generate adaptive annotations based on user interactions, promoting deeper critical analysis (Cunningham-Nelson et al., 2019).

3.3 Capstone Integration and Assessment

Teams collaborate with communities to build enriched twins, activating all Five Big Ideas in AI (AI for K-12 Working Group, 2021). Agentic AI can facilitate this by coordinating data flows and suggesting ethical adjustments in real-time. Public presentations justify technical, interpretive, and ethical choices, ensuring accountability.

4. Future Research and Implications

The 'Enriched Twin' framework, as proposed in this article, is not intended as a finished product but rather as a dynamic, evolving model that invites rigorous empirical investigation and iterative refinement. Its implementation in real K-12 classrooms offers fertile ground for multiple lines of scholarly inquiry that can contribute meaningfully to the intersecting fields of educational technology, digital humanities, curriculum studies, and AI ethics. Three complementary yet distinct research trajectories are proposed below, each designed to generate robust, transferable knowledge about the pedagogical efficacy, ethical implications, and community impact of integrating agentic AI and digital twins into heritage education.

4.1 Trajectory A: Cognitive-Affective Exploration of Student Learning Outcomes

The first line of inquiry adopts a mixed-methods, quasi-experimental design to systematically evaluate the holistic impact of the Enriched Twin curriculum on students' cognitive, affective, and ethical development. A treatment group participating in the full curriculum would be compared with a matched control group receiving conventional digital heritage or technology education. Key research questions include:

- To what extent does participation in the Enriched Twin program enhance students' technical proficiency in drone-based data capture, 3D modeling, and agentic AI application?
- How does the curriculum influence students' critical awareness of cultural diversity, historical power imbalances, and the epistemic biases embedded in AI systems?
- In what ways does engagement with community co-creation and decolonizing methodologies foster empathy, ethical reasoning, and a sense of responsibility toward cultural heritage stewardship?

Quantitative instruments would include pre- and post-intervention assessments of technical skills, validated scales measuring cultural competence and AI literacy, and attitudinal surveys on ethical responsibility. Qualitative data would be collected through analysis of student artifacts, semi-structured focus group interviews, and classroom observations. Longitudinal follow-up studies could track whether these learning outcomes persist over time or transfer to other academic and civic contexts.

4.2 Trajectory B: Design-Based Research for Iterative Framework Validation and Refinement

The second trajectory employs Design-Based Research (DBR) methodology (Cobb et al., 2003) to collaboratively develop, implement, test, and refine the Enriched Twin framework in authentic educational contexts. Working closely with practicing teachers, school administrators, and community partners, researchers would conduct multiple iterative cycles of design-enactment-analysis-refinement. Core research questions include:

- What are the essential design principles, instructional scaffolds, and facilitation strategies that enable successful implementation of the Enriched Twin curriculum across diverse school settings?
- How do variations in teacher expertise, student age/grade level, and community partner characteristics influence the feasibility, fidelity, and outcomes of the curriculum?
- What adaptations are required to make the framework scalable and sustainable within existing school infrastructures, budgets, and scheduling constraints?

Each iteration would produce refined curriculum materials, professional development resources, and implementation guidelines grounded in both critical theory and classroom practice.

4.3 Trajectory C: Participatory Action Research on Community-School Co-Creation Dynamics

The third trajectory focuses on the socio-cultural and relational dimensions of the curriculum through a Participatory Action Research (PAR) approach. Researchers would embed themselves within selected school-community partnerships to document, analyze, and co-interpret the processes and outcomes of collaborative digital twin creation. Central questions include:

- What tensions, power dynamics, and negotiation processes emerge when K-12 students, teachers, and heritage community members co-construct enriched digital twins?

Data collection would involve ethnographic observation, in-depth interviews, co-created reflective artifacts, and analysis of data sovereignty agreements and Traditional Knowledge Labels. The resulting thick descriptions and critical case studies would serve as powerful exemplars for ethical community-school collaboration in the digital humanities. An additional extension could explore the integration of agentic AI in these partnerships, examining how autonomous agents facilitate or complicate decolonizing processes (Jones, 2025).

Collectively, these three research trajectories would generate a robust, multi-layered evidence base that not only validates the Enriched Twin framework but also contributes foundational knowledge to broader debates about responsible AI integration in education, decolonizing digital practices, and the role of schools in cultural heritage stewardship.

5. Conclusion

The 'Enriched Twin' framework represents a deliberate shift away from technology-centric digital heritage education toward a critically conscious, humanistic, and ethically grounded model. By centering agentic AI-augmented digital twins within a project-based STEAM curriculum and embedding critical AI hermeneutics and decolonizing methodologies throughout, this approach empowers K-12 students to become more than skilled technicians. It cultivates them as responsible digital stewards capable of interrogating biases, practicing data sovereignty, and co-creating culturally respectful representations of heritage. In an era of widespread agentic AI adoption, this framework offers a pathway to transform digital education into a site of social justice and cultural empowerment.

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Industrial Design Education: A Literature Review

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Abstract

This review synthesizes research on industrial design education, highlighting technology integration and sustainability as key drivers. Studies explore the adoption of digital tools like VR and 3D modeling, balancing their potential for enhancing creativity with concerns over preserving traditional skills. Sustainability education research emphasizes practical, project-based learning to embed environmental principles, though implementation faces contextual challenges. Investigations into teaching methods reveal insights into student cognitive processes and the effectiveness of technological interventions. Furthermore, the field examines how policy and cultural factors shape curricula, alongside evolving career trends toward UX roles and interdisciplinary competencies. Methodologically diverse, the literature provides practical frameworks for educators. However, it remains fragmented, relying heavily on context-specific, small-scale studies, which limits generalization. Critical gaps include a lack of longitudinal data on skill retention, insufficient integration of emerging technologies like AI, and limited cross-cultural comparisons. Future research should prioritize longitudinal and comparative studies, deeper exploration of advanced technologies aligned with sustainability goals, and stronger industry collaboration to ensure curricula meet evolving professional demands.

Keywords: industrial design, education, review

1. Introduction

Industrial design education plays a pivotal role in shaping future innovators' ability of addressing complex global challenges, as it bridges technological advancement, sustainability goals, and human-centered design. The theoretical significance lies in integrating diverse disciplinary insights to redefine educational paradigms, while practical value stems from guiding curriculum development and pedagogical innovation to meet evolving industry demands. In recent decades, the field has witnessed rapid expansion, with growing attention to technological integration, sustainability imperatives, and interdisciplinary collaboration, yet existing research remains fragmented across specialized sub domains. This review first explores the impact of technology and digitization on industrial design curricula, examining how emerging tools reshape pedagogical approaches; it then delves into sustainability and eco-design education, analyzing how environment principles are integrated into learning frameworks. Next, the focus shifts to teaching methodologies and student learning processes, investigating effective strategies to enhance creative and technical competencies. The review further examines how education systems, policy and culture contexts influence program structures and institutional priorities, before exploring the evolving career landscape and skill requirements for modern industrial designers. Finally, it addresses interdisciplinary and non-design major design education, highlighting the role of inclusive design literacy in fostering cross-sector innovation. By synthesizing these interconnected areas, this review aims to construct a comprehensive analytical framework, map the evolution of industrial design education research, identify critical knowledge gaps, and provide a foundational reference for educators, policymakers, and researchers seeking to advance the field.

2. Technology and Digitization in Industrial Design Education

Technology and digitization have emerged as reformative forces in industrial design education, driving shifts in pedagogical approaches, tool integration, and interdisciplinary collaboration. This evolution reflects the need to align educational practices with industry demands for technology-driven innovation, while addressing tensions between digital tools and traditional design skills. Recent research has focused on understanding how digital technologies — including virtual reality (VR), 3D modeling software, and digital prototyping — can enhance learning outcomes, and how educators can effectively integrate these tools into curricula.

The adoption of digital tools in industrial design education has been shaped by both opportunities and challenges, particularly regarding tool functionality, user needs, and skill development. Lianget et al. (2016) identified critical functional requirements for VR systems in design education using a ZMET-QFD model, with students prioritizing real-world parameters, physical databases, and multiple viewpoints to support intuitive design exploration. Jimeno et al. (2016) further proposed a VR-based methodological framework to enhance creativity by overcoming visualization limitations of traditional prototypes, though their study noted the need for empirical assessment of creativity gains. Conversely, Hamurcu et al. (2023) highlighted barriers to VR adoption, with students and instructors expressing concerns about potential erosion of manual dexterity and material knowledge, underscoring the need to balance digital tools with hands-on skills. For 3D modeling software, Yilmaz and Gelmez (2025) found that students prioritize affordability, ease of use, and compatibility, with peer learning driving 60% of software adoption; they developed an 11-dimensional evaluation framework to align tools with design-specific creative workflows. Aldoy and Evans (2021) similarly noted resistance to fully digital processes, as stakeholders questioned the replacement of paper-based sketching and physical model making, citing tactile experiences as irreplaceable for design development.

Pedagogical innovations have centered on structuring technology-driven design processes and fostering interdisciplinary collaboration. Ahmet and Curaoğlu (2017) emphasized design labs as interdisciplinary hubs, enabling interactions between design and technology disciplines to enhance the usability of emerging technologies in products and services. Kim et al. (2022) addressed gaps in teaching technology-driven new product development (NPD) by developing a grounded theory model, derived from interviews and syllabus analysis, to guide mentoring in technical design contexts. Kucuksayrac (2023) complemented this with two frameworks for digital prototyping education: one linking product completeness to user intervention types, and another connecting user engagement scenarios to environmental and economic sustainability, highlighting the need to embed sustainability in digital design practices.

These studies collectively advance understanding of digitization in industrial design education by providing tool evaluation frameworks, VR implementation guidelines, and pedagogical models. Methodologically, they employ diverse approaches — including case studies (Kucuksayrac, 2023), surveys (Yilmaz and Gelmez, 2025), grounded theory (Kim et al., 2022), and qualitative analysis (Hamurcu et al., 2023) — strengthening the validity of findings. However, limitations include a focus on short-term tool adoption over long-term skill retention, limited exploration of institutional or cultural variations in technology integration, and under representation of emerging tools like AI-driven design assistants. Future research should address these gaps by investigating longitudinal skill development, cross-institutional comparisons, and the integration of advanced technologies with sustainability and ethical considerations in curricula.

3. Sustainability and Eco-Design Education Research

Sustainability and eco-design education research occupies a critical position in advancing industrial design practices that align with environmental goals and circular economy principles. As highlighted by Van et al. (20 20), design education for the circular economy is one of four key thematic areas through which industrial design can contribute to systems-level sustainability transitions, emphasizing the need to cultivate designers' capacity to integrate environmental considerations into product development processes. This sub field addresses not only the technical and methodological aspects of teaching eco-design but also the sociocultural and contextual factors that shape student learning and design outcomes, making it essential for bridging academic knowledge and practical application in sustainable product development.

Empirical studies across different educational contexts have explored the implementation and impacts of eco-design education, revealing both common trends and region-specific challenges. In Japan, Ueda (2018) conducted an experimental learning project with undergraduate industrial design students, finding that participants exhibited a strong inclination toward sociocultural approaches to sustainable consumption rather than technological eco-design solutions. Their study identified barriers such as complex support tools incompatible with students' academic backgrounds, alongside systemic issues like limited eco-design expertise among educators and poor integration of eco-design modules into curricula. Similarly, in Spain, Perez and Bovea (2016) organized workshops for industrial design engineering students focused on electrical and electronic toys, demonstrating that practical training on product end-of-life and environmental issues increased students' willingness to incorporate environmental requirements into their design processes. Meanwhile, at Middle East

Technical University, Dogan et al. (2016) integrated sustainability considerations — including product evolution, maintenance, and resource efficiency — into undergraduate design projects, developing a generative design research method and idea generation tool to facilitate students' understanding of sustainability in the ideation phase. Collectively, these studies highlight the importance of practical, project-based learning in eco-design education, though they differ in their focus: Ueda (2018) emphasize sociocultural orientations, Perez and Bovea (2016) focus on end-of-life considerations, and Dogan et al. (2016) prioritize tool development for idea generation.

The literature contributes valuable insights into the current state of eco-design education, yet several limitations and gaps persist. Methodologically, most studies rely on small-scale, context-specific case studies — such as Ueda (2018) noting limited participants, resources, and time — which constrain the generalizability of findings. The geographical focus is also narrow, with studies concentrated in Japan, Spain, and Turkey, leaving a lack of comparative research across diverse cultural and educational systems. Additionally, while Van et al. (2016) identify design education for the circular economy as a key thematic area, their review underscores that this body of knowledge remains under-systematized, with insufficient analysis of how educational interventions translate into long-term professional practice. Barriers to effective eco-design education, such as inadequate educator expertise (Ueda, 2018) and tool complexity, also require further investigation into scalable solutions. These gaps point to the need for more robust, longitudinal studies and cross-institutional collaborations to strengthen the evidence base for eco-design education practices.

4. Industrial Design Teaching and Student Learning Research

Industrial Design Teaching and Student Learning Research is a critical domain that bridges pedagogical strategies, student cognitive processes, and the practical application of design knowledge, directly addressing the need to cultivate competent designers capable of meeting evolving industry demands. This area explores how teaching methods, curriculum design, and learning resources influence students' acquisition of technical skills, creative thinking, and professional competencies, while also examining the interplay between student characteristics (e.g., cognitive styles, sustainability awareness) and learning outcomes. Understanding these dynamics is essential for optimizing industrial design education to foster innovation, human-centered design, and adaptability in graduates.

Contemporary research in this field encompasses diverse thematic foci, including curriculum integration of humanistic and artistic elements, student cognitive processes during design activities, the impact of technology-enhanced teaching tools, and the application of experiential knowledge. Kang and Liu (2018) emphasize the growing importance of humanized design in modern industrial design, arguing that academic programs must integrate humanistic artistic elements into teaching to align with consumer demands. They define these elements from a humanization perspective, analyze current educational gaps, and propose strategies to strengthen such integration. Complementing this, Tatlisu and Kaya (2017) explore how industrial design graduates apply experiential knowledge — rooted in engineering, ergonomics, esthetic, and culture — in non-traditional professional contexts, highlighting the compound nature of design knowledge and its transferability beyond orthodox design fields.

Studies on student cognitive processes and learning challenges reveal distinct patterns in design thinking and resource utilization. Chen (2016) identifies concept generation, design presentation, and design research as the most challenging tasks for undergraduate students in studio courses, with learning resources categorized into people, objects, methods, and environments. Further, Chen et al. (2023) distinguish between problem-driven and solution-driven students using the P-S index derived from the Function-Behavior-Structure (FBS) ontology, finding that problem-driven students focus on problem statement, while solution-driven students prioritize solution structure development; notably, these cognitive classifications remain stable across experimental conditions, with constraints disproportionately intensifying solution-driven students' design processes.

Technological advancements have also reshaped teaching and learning dynamics, as evidenced by studies on visual information processing and digital interventions. Mao and Zhang (2024) employed eye-tracking to investigate how industrial design students read technical versus design articles, and discovered that technical articles generate more text attention and top-down reading, while design articles generate more image attention and image-text interaction reading; recall scores for technical articles correlated with text reading time and fixation count, while design article inference scores correlated with image-related metrics, with upper-grade students demonstrating superior image focus and inference performance. Similarly, Mao et al. (2024) explored sustainable design education, finding that students with higher sustainability levels (assessed via the Sustainable Consumption Measurement Scale) exhibited elevated perspective scores in theoretical articles and longer image fixation duration in case articles, with female students and those with design experience performing better in sustainability related tasks. In terms of teaching interventions, Chen et al. (2025) demonstrated that integrating video tutorials into model-making workshops enhanced first-year students' self-regulated learning, cognitive

strategy use, and learning outcomes compared to traditional demonstration-based teaching.

Collectively, these studies contribute valuable insights into optimizing industrial design education by addressing curriculum design, cognitive diversity, technological integration, and domain-specific competencies like sustainability. Methodologically, the research employs diverse approaches, including surveys (Chen, 2016), eye-tracking (Mao & Zhang, 2024; Mao et al., 2024), mixed-methods (Chen et al., 2025), and cognitive process analysis (Chen et al., 2023), enhancing the robustness of findings. However, limitations persist: sample selection often focuses on specific student cohorts (e.g., first-year students in Chen et al., 2025), potentially limiting generalizability; Tatlisu and Kaya's (2017) exploratory study lacks explicit sample size details, reducing repeatability; and Kang and Liu's (2018) focus on humanistic elements predates recent technological disrupt ions in design education (e.g., AI tools). Notable research gaps include cross-cultural comparisons of teaching approaches, long-term longitudinal studies on skill retention, and the integration of emerging technologies (e.g., virtual reality) in design studios.

5. Industrial Design Education System and Policy

The intersection of industrial design education systems with policy and cultural factors is critical for understanding how educational frameworks evolve to meet societal, economic, and technological demands. Policy directives shape educational priorities, resource allocation, and curricular reforms, while cultural contexts influence pedagogical approaches, student expectations, and the perceived value of design education. This interplay is particularly evident in comparative studies across regions, where differing policy landscapes and cultural values yield distinct educational models and outcomes.

Cross-cultural and policy-driven analyzes reveal divergent approaches to industrial design education. Chen (2018) conducted a comparative study of Chinese and Western industrial design education systems, identifying key disparities in curriculum, teaching modes, and evaluation. The Chinese system was found to suffer from homogenized teaching, insufficiently distinctive curricula, and subjective evaluation standards, prompting recommendations to integrate Western educational concepts through featured courses, improved teaching modes, and diversified evaluation. In contrast, Deighton et al. (2024) examined Australian industrial design education across primary, secondary, and tertiary levels, focusing on 21st-century competence development. Their mixed-method study (surveys and stakeholder interviews) highlighted a disconnect between design educators' recognition of design's broad skill value and the wider public's perception of design as "surface decoration", emphasizing the need to align educational outcomes with societal relevance. Policy influence is a central theme in Chinese industrial design education research. Li et al. (2023) employed bibliometric analysis and policy historical analysis to map the evolution of Chinese industrial design education from 1992 to 2021, identifying "government, industry, academia and research" cooperation as a core research theme, alongside "Chinese culture" and "inter disciplinary cooperation". They noted that national policies have driven key research hot spots, including innovation and entrepreneurship education, interdisciplinary integration under "new engineering" and evaluation system reforms for high-quality development. Complementing this, Hu et al. (2021) explored integrated innovation design education in a Chinese university, demonstrating how policy-driven reforms (e.g., aligning teaching objectives, contents, and evaluation with entrepreneurial ability training) enhanced students' innovative and entrepreneurial success rates, offering a practical model for adapting to design industry transformation.

Collectively, these studies contribute valuable insights into the dynamic relationship between policy, culture, and industrial design education. Chen (2018) and Li et al. (2023) illuminate China's policy and culture influenced reform trajectory, while Deighton et al. (2024) provides an Australia perspective on competence alignment and public perception. Methodologically, however, limitations exist: Chen's (2018) comparative analysis lacks longitudinal data on curriculum evolution; Hu et al. (2021) focuses on a single university case, limiting generalizability; Li et al. (2023) relies on CNKI (A literature retrieval database of China like Web of Science) data, potentially excluding international research; Deighton et al. (2024) does not explicitly link competence frameworks to policy drivers. Notable research gaps include cross-national and policy-cultural comparisons (e.g., China vs. Australia), long-term tracking of policy impact on educational outcomes, and deeper analysis of how cultural values (e.g., collectivism vs. individualism) shape teaching and evaluation practices.

6. Career Development and Skill Requirements for Industrial Designers

The career development and skill requirements of industrial designers have evolved significantly in response to global economic shifts, technological advancements, and changing market demands. Understanding these dynamics is critical for aligning design education with industry needs and supporting designers in navigating diverse professional pathways. Recent studies highlight emerging trends in employment patterns, the integration of new skill sets, and the expanding role of industrial designers beyond traditional product development.

Care development trajectories for industrial designers reflect both continuity and transformation in employment

structures. In Turkey, longitudinal analysis spanning 1984–2018 shows that in-house employment remains the dominant form, with a notable rise in user experience (UX)-focused roles as a distinct and growing subcategory (Suner et al, 2019). This shift coincides with industrial design students increasingly considering UX careers, driven by perceptions of expanded professional opportunities and the potential to mitigate challenges in the traditional industrial design job market (Kaygan et al, 2020). Currently, the decline in self-employment has been offset by a surge in freelance work, indicating a move toward more flexible employment models (Suner et al, 2019). In Israel, the integration of entrepreneurship into design practice has emerged as a key trend, with efforts to position industrial designers as "creative leaders" through entrepreneurial thinking and lifelong learning, reflecting a broader global redefinition of the designer's role in business innovation (Schneorson et al, 2019). Additionally, the role of industrial designers in innovation-based companies, as explored in the case of Odtü Teknokent, suggests further diversification of professional functions beyond product design (Turhan, 2023).

Skill requirements for industrial designers are expanding to encompass both technical and transdisciplinary competencies. While traditional design skills remain foundational, the UX field demands additional capabilities that industrial design students perceive as aligned with their educational background, including user-centered design and problem-solving (Kaygan et al, 2020). In Israel, entrepreneurial thinking is increasingly recognized as a critical skill set, yet it is often still viewed as business-related rather than integral to innovative design practice, highlighting a disconnect in higher education curricula (Schneorson et al, 2019). This gap is compounded by structural barriers to top -down changes in design education, underscoring the need for educational interventions that explicitly integrate entrepreneurial principles into design training. The rise of UX-focused roles further emphasizes the importance of adaptive skills, as industrial design graduates must bridge their core training with UX-specific knowledge to transition effectively into these positions (Suner et al, 2019; Kaygan et al, 2020).

Collectively, these studies provide valuable insights into regional variations and emerging trends in industrial design careers, but several limitations and gaps persist. Methodologically, the Turkish employment analysis relies on data from only four institutions, potentially limiting generalizability (Suner et al, 2019), while the focus on student perceptions in UX career pathways (Kaygan et al, 2020) lacks perspectives from practicing designers or employers. The Israeli case study identifies structural barriers in higher education but offers limited empirical data on the effectiveness of proposed interventions like the "creative leaders" prototype (Schneorson et al., 2019). Additionally, the study on innovation-based companies (Turhan, 2023) lacks an available abstract, restricting detailed analysis of the specific roles and skills required in such contexts. Future research should address these gaps by incorporating multi-institutional and cross-regional data, exploring practitioner experiences in emerging fields like UX, and examining the implementation of entrepreneurial and lifelong learning frameworks in design education.

7. Interdisciplinary and Non-Design Major Design Education

Interdisciplinary and non-design major design education has become increasingly significant in equipping students from diverse academic backgrounds with design thinking and problem-solving skills, bridging traditional disciplinary silos to address complex real-world challenges. This area of study explores how design principles can be effectively integrated into non-design curricula, examining both the perception and development of design competencies among non-design students, as well as the structural evolution of design education programs across disciplines.

Wu and Mejía (2025) investigated non-design majors enrolled in a first-year industrial design foundations course, focusing on five core competencies — synthesis, speculation, modeling, facilitation, and implementation. Through qualitative interviews, they found that students recognized design's value in fostering creativity and managing uncertainty, with reflective practice emerging as a key factor in developing a design mindset, though collaborative competencies remained challenging to cultivate in non-traditional settings. Complementing this focus on student experiences, Beecher (2025) explored the historical evolution of interior design education at The Ohio State University, documenting its transition from a component of a multi-faceted industrial design program to a stand-alone accredited discipline, offering insights into how design education structures adapt to interdisciplinary and specialized needs. Meanwhile, De and Floré (2025) address interior design education through the lens of expanding design history via educational narratives, which may intersect with interdisciplinary approaches by contextualizing design within broader historical frameworks, though specific methodologies and findings are not detailed in available abstracts.

The reviewed literature contributes diverse perspectives to interdisciplinary and non-design major design education: Wu and Mejía (2025) provide empirical data on student competency development, Beecher (20 25) offers institutional and historical context for design program evolution, and De and Floré (2025) suggest potential narrative-based strategies for enriching design education. Methodologically, Wu and Mejia's (2025) qualitative approach captures nuanced student perceptions but is limited to a single institution and course, raising

questions about generalizability. Beecher's (2025) reliance on archival materials and interviews provides valuable historical depth but is constrained to a specific institutional case. The lack of abstract for de De and Floré (2025) limits critical assessment of their contribution, highlighting a gap in accessible research details. Key research gaps include longitudinal studies on the long-term impact of design education on non-design students, comparative analyzes across institutions, and empirical validation of narrative-based pedagogies in interdisciplinary contexts.

8. Summary Assessment

Collectively, the reviewed literature advances industrial design education research by addressing critical themes including technological integration, sustainability, pedagogical innovation, policy-cultural dynamics, career development, and interdisciplinary learning. Methodologically diverse approaches — ranging from surveys (Yilmaz & Gelmez, 2025) and grounded theory (Kim et al., 2022) to eye-tracking (Mao & Zhang, 2024; Mao et al., 2024) and bibliometric analysis (Li et al., 2023) — strengthen the empirical foundation, while contributions such as tool evaluation frameworks (Yilmaz & Gelmez, 2025), VR implementation guidelines (Lianget et al., 2016; Jimeno et al, 2016), and policy-driven reform models (Li et al., 2023) offer practical value for educators and policymakers. However, the field exhibits notable fragmentation: studies often focus on isolated subtopics (e.g., VR adoption (Hamurcu et al.,2023) vs. circular economy education (Van, 2020)), with limited cross-thematic integration. Additionally, geographical concentration (e.g., sustainability research in Japan (Ueda, 2018), Spain (Perez & Bovea, 2016), and Turkey (Doganet al., 2016); Chinese policy analysis (Chen, 2018; Li et al., 2023)) and small -scale case studies (Ueda, 20218; Wu & Mejía, 2025) constrain generalizability, while short-term tool adoption and intervention studies predominate over longitudinal investigations of skill retention and professional impact.

8. Research Gaps

Key gaps persist across methodological, theoretical, and empirical dimensions. Methodologically, there is an over reliance on context-specific, small-sample studies (Ueda, 2018; Wu & Mejía, 2025), with insufficient large-scale cross-institutional or cross-cultural comparisons (e.g., China vs. Western educational models (Chen, 2018)). Theoretically, the field lacks integrative frameworks that bridge technological, sustainability, and pedagogical themes, limiting holistic understanding of education -system dynamics. Empirically, critical gaps include: under representation of emerging technologies (e.g., AI-driven design tools) beyond VR and 3D modeling (Yilmaz & Gelmez, 2025); limited employer perspectives on skill requirements (Suneret et al., 2022; Kaygan et al., 2020); inadequate data on long-term professional outcomes of interdisciplinary and sustainability education (Van et al., 2020; Wu & Mejía, 2025); and insufficient analysis of how cultural values (e.g., collect individualism vs. individual ism) shape teaching practices and student learning (Deighton, 2024; Chen, 2018).

9. Future Research Directions

Future research should prioritize three strategic areas: (1) Cross-cultural and longitudinal studies to examine skill retention, curriculum evolution, and professional impact across diverse educational systems, addressing gaps in geographical generalizability. (2) Integration of emerging technologies (e.g., AI design assistants) into curricula, with empirical assessment of their interplay with traditional skills and sustainability goals. (3) Strengthened industry–education collaboration to align skill development with evolving career demands (e.g., UX roles, entrepreneurial competencies), including mixed-method studies incorporating employer and practitioner perspectives. Additionally, research on narrative-based pedagogies and the long-term effects of interdisciplinary education on non-design majors could enrich pedagogical innovation, while systemic analyzes of policy-cultural drivers would enhance understanding of global education reform trajectories.

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Integrating Indigenous Knowledge Transition Correlates Higher Education Curricula: A Case Study from Busitema University

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Abstract

This study looks at the inclusion of Indigenous Knowledge (IK) in Higher Education curricula with a case study of Busitema University in Uganda and it objectively focused on investigating the current practices and existing curricula IK incorporation challenges. The study employed qualitative case study approach, conducting semi-structured interviews while interacting with teaching faculty, students, and university administrators and results were interpreted and analyzed thematically. The findings indicated that IK integration is limited but starting to grow. This growth is hindered by slow changes at the institution, a lack of faculty knowledge, and no clear policies. The study suggests that effectively incorporating IK requires inclusive curriculum frameworks, training for academic staff, and working together with indigenous communities. Recommendations focus on creating policies, developing faculty programs, and forming partnerships to improve culturally relevant education. This study adds to the ongoing discussion about decolonizing curricula and endorsing indigenous ways of knowing in Uganda and similar educational settings.

Keywords: indigenous knowledge, curriculum integration, higher education, decolonization, Busitema University

1. Background of the Study

Universities serve as producers of knowledge and as cultural gatekeepers that influence how authority and identities are formed (Smith, 2021). Decolonizing higher education curricula means restructuring ways of knowing. This involves validating Indigenous Knowledge systems, questioning colonial legacies in scholarship, and altering teaching methods to support indigenous identities and communities (Battiste, 2013; Makokotlela & Gumbo, 2025). Indigenous Knowledge (IK) includes the practical wisdom, cultural traditions, and ecological understanding developed by indigenous communities through centuries of interaction with their environments (Ecology, S., 1999; David, M. T. et al., 2025). Despite its inherent value, formal education systems worldwide, largely influenced by colonial and Western ideas, have often overlooked these knowledge systems (Ezra, W., & Charles, M. 2023). This has led to Western knowledge being prioritized, which contributes to cultural disenfranchisement (Battiste, 2013; Smith, 2021). This hierarchy creates injustice, silencing indigenous perspectives in educational programs and deepening cultural separation.

Global efforts to address this issue include international legal frameworks like the United Nations Declaration on

the Rights of Indigenous Peoples (Champagne, D., 2013), which supports indigenous people's rights to protect, control, and develop their cultural knowledge and education systems. Additionally, UNESCO and other international organizations promote the integration of Indigenous Knowledge into formal education to encourage diversity, cultural sustainability, and relevance in learning (Agrawal, 2002; Simpson, 2017). Across Africa, universities are facing growing pressure to decolonize their curricula by including Indigenous Knowledge. This shift is deemed essential for promoting sustainable development and affirming cultural identities (Makokotlela & Gumbo, 2025; Seleke, 2025).

In Uganda, policies like the National Culture Policy (Ministry of Gender, Labour and Social Development, 2016) and the National Council for Higher Education (NCHE) curriculum development guidelines (NCHE, 2022) align with global calls for knowledge diversity. However, putting Indigenous Knowledge into practice remains limited due to challenges with institutions, teaching methods, and available resources. This rotates around all universities in Uganda such as Makerere University, Muteesa I Royal University, among others and for this study, focus is on Busitema University. Busitema University, located in Eastern Uganda, is a key public institution for a mainly indigenous student population with strong cultural ties to agriculture, herbal medicine, and environmental care. The university is recognized both regionally and nationally for its work in researching and promoting Indigenous Knowledge, especially through its Natural Products Research and Innovation Centre (NaPRiC). NaPRiC functions as an important link between indigenous herbal practices and modern scientific research, fostering holistic healthcare and innovation that reflects local needs (Busitema University, 2025).

Despite these significant research and innovation initiatives, the thorough integration of Indigenous Knowledge into the curriculum at Busitema University is still in its early stages. The university's strategic plan highlights the need for education that is contextualized and innovative but points out challenges in implementing this integration, such as a lack of clear policies, insufficient faculty training in Indigenous teaching methods, and institutional structures that do not fully support inclusive knowledge practices (Busitema University Strategic Plan, 2018). This divide between research activities and curriculum development underscores the need for this study, which aims to provide practical insights to help effectively incorporate Indigenous Knowledge into the university's programs and support broader higher education reforms in Uganda.

Indigenous Knowledge (IK): Indigenous Knowledge consists of community-developed and orally transmitted knowledge systems. These knowledge systems govern various areas like ecology, health, agriculture, cultural norms, and social organization (Tumwesigye, W., et al., 2023; Ecology, S., 1999). IK includes adaptive strategies and cultures specific to indigenous peoples and environments. Its holistic and relational way of knowing differs significantly from Western scientific approaches, which often break down knowledge into parts and aim for universal truths. This difference creates challenges when trying to incorporate IK into formal education (Agrawal, 2002). At Busitema University, efforts led by the Natural Products Research and Innovation Centre (NaPRiC) show that the institution recognizes the importance of IK. This recognition is especially prominent in areas like ethno-pharmacology and natural products, where researchers look into indigenous herbal knowledge alongside scientific methods to connect different knowledge systems (Busitema University, 2025; Nabatanzi, A., et al., 2025).

Curriculum integration goes far intentionally including Indigenous Knowledge in academic programs (Thomas, W. & Charles, M., 2022). This can happen through core modules focused on IK, adding IK content to regular subjects, or teaching methods that emphasize experiential and participatory learning related to indigenous cultural practices (Barnhardt & Kawagley, 2005). Such integration challenges traditional knowledge hierarchies that prioritize Western ways of knowing and creates inclusive, culturally relevant learning spaces that respect indigenous perspectives (Seleke, 2025). Busitema University's efforts toward contextualized education reflect the early stages of implementing these integrative methods, highlighting the opportunities and challenges of authentically including IK in academic programs (Busitema University Strategic Plan, 2018).

This process is essential for creating fair education systems that recognize various ways of knowing and respect different worldviews. At Busitema University, the goals of decolonization appear in both policy directions and research projects. These include efforts that link indigenous herbal knowledge with modern scientific research, showing that higher education can become a significant space for indigenous ways of knowing (Busitema University, 2025; Nabatanzi, A., et al., 2025).

1.1 Purpose of the Study

The purpose of this study is to investigate the current practices, barriers, and enhancement strategies for integrating Indigenous Knowledge into the curricula of Busitema University, to support educational relevance, epistemic justice, and cultural continuity.

1.2 Research Objectives

The study was guided by the following objectives:

1) To explore current practices related to Indigenous Knowledge integration in Busitema University's curricula.
2) To identify challenges impeding effective Indigenous Knowledge integration at the university.
3) To formulate recommendations for sustainable integration of Indigenous Knowledge in university curricula.

1.3 Research Questions

This study intended to respond to the following questions:

1) What are the current practices of Indigenous Knowledge integration within Busitema University's curricula?
2) What barriers hinder the effective integration of Indigenous Knowledge in the university's programs?
3) What strategies can be adopted to improve Indigenous Knowledge incorporation in higher education curricula?

1.4 Theoretical Framework

This study was guided by Decolonial Theory with the intention of examining the ongoing dominance of Western knowledge frameworks and their role in marginalizing indigenous knowledge within academic institutions (Battiste, 2013). It questions the claims that Western knowledge is universal and argues for a system where diverse knowledge systems exist with equal validity (de Sousa Santos, B., 2015; Tarisayi, 2024). In the context of higher education curriculum reform, Decolonial Theory highlights the importance of epistemic justice. It seeks to break down cognitive imperialism and restore indigenous knowledge as independent and essential rather than peripheral (Makokotlela & Gumbo, 2025). Recent studies stress that ethical inclusion of Indigenous Knowledge (IK) requires moving beyond superficial inclusion. It calls for placing IK at the center of knowledge creation and teaching practices (Tarisayi, 2024; Madziva & Wadesango, 2021). The theory plays a crucial role in this study in way that it frames the inclusion of IK at Busitema University as a transformative effort to challenge historical colonial assumptions in curricula. This shift promotes knowledge diversity and social justice. The theory guides the analysis of Busitema University's curriculum reform strategies. It explores how entrenched Western knowledge can be reshaped to inclusively represent indigenous knowledge in line with decolonial goals (Nandagire, P., et al., 2023).

2. Literature Review

2.1 Indigenous Knowledge in Education

Several studies show that Indigenous Knowledge (IK) is still underrepresented in global, especially African, higher education curricula. This is despite IK's important role in promoting cultural sustainability, solving community problems, conserving biodiversity, and engaging learners (Banda, F. & Banda, D., 2016; Dei, Hall & Rosenberg, 2000; Kaya & Seleti, 2013). Incorporating IK is seen as essential for making higher education institutions more relevant to their contexts and responsive to development (Kaya & Seleti, 2013). In South Africa, programs at institutions like North-West University show that integrating Indigenous Knowledge Systems (IKS) into research, teaching, and community engagement improves the educational experience and connects academic and community gaps. However, this integration faces obstacles like Western epistemological dominance, limited faculty knowledge, and unclear institutional support (Makokotlela & Gumbo, 2025; Seleke, 2025). Case studies from Southeast Asia show notable success where ethnobotanical and indigenous ecological knowledge are included in science curricula. This results in greater collaboration across disciplines and stronger community empowerment (Tanjung et al., 2025). In Uganda, while some universities and public policies support initiatives, most curriculum changes to include IK are still limited; comprehensive institutional frameworks are still lacking (Magara, 2024; NCHE, 2022; Mugabirwe & Turyamureeba, 2025).

2.2 Curriculum Integration Models

Integrating IK in higher education usually follows three main models: embedding IK content into existing courses, creating dedicated IK modules or program specializations, and engaging with indigenous experts and cultural practitioners as co-educators or mentors (Barnhardt & Kawagley, 2005; Seleke, 2025; Kaya & Seleti, 2013). Effective integration requires ongoing collaboration among academics, indigenous communities, and policymakers. This ensures cultural respect, epistemic accuracy, and relevance to the context (Druker-Ibanez, S. & Caceres-Jensen, L. 2022). Transdisciplinary approaches, which involve crossing academic boundaries and treating indigenous stakeholders as equal partners, are considered best practice. This is particularly true in technology education, environmental science, and public health (Barnhardt & Kawagley, 2005; Seleke, 2025; Mugabirwe & Turyamureeba, 2025).

2.3 Challenges and Opportunities

The literature points out several ongoing challenges to integrating IK. The most prominent issues include the continued dominance of Western knowledge systems, faculty unpreparedness, lack of relevant teaching training, unclear institutional policies, limited resources, and ethical concerns related to cultural appropriation (Ryan, J. & Ivelja, J. 2023; Seleke, 2025; Madziva & Wadesango, 2021). As Kaya and Seleti (2013) note, without strong institutional commitment and adequate resources, IK initiatives often become unsustainable or merely symbolic. Still, policy changes like those from Uganda's National Council for Higher Education (NCHE, 2022) and new digital knowledge-sharing platforms are creating new opportunities for inclusive curriculum reform, increased indigenous participation, and different forms of learning engagement (Magara et al., 2024; Mugabirwe & Turyamureeba, 2025). This blending of policy, technology, and indigenous advocacy indicates a significant movement toward more inclusive, ethical, and context-sensitive curriculum changes in African and global higher education.

3. Methodology

3.1 Research Design

This study employed a qualitative case study design to investigate the integration of Indigenous Knowledge (IK) into the curricula of Busitema University. A case study is an ideal design for exploring complex, context-dependent phenomena where boundaries between the phenomenon and its environment are not clearly defined (Creswell & Poth, 2016). This method allows researchers to holistically examine real-life experiences and processes within institutional settings. Given the multifaceted nature of IK spanning cultural traditions, local epistemologies, and pedagogical frameworks a case study design is particularly useful in capturing diverse stakeholder experiences, policies, and implementation challenges. This approach is consistent with research traditions in Indigenous Knowledge studies that prioritize community engagement, cultural sensitivity, and contextual understanding (Kaya & Seleti, 2013; Adyanga, F. A. & Romm, N. R. A., 2016).

3.2 Target Population

The target population consisted of **fifteen (15)** participants directly involved in or impacted by the integration of Indigenous Knowledge into the academic processes at Busitema University. The participants were strategically drawn from three key stakeholder groups:

- **Faculty Members (6):** These participants are responsible for curriculum development, course content delivery, and academic mentorship. Their involvement was essential in understanding how IK is conceptualized, interpreted, and integrated into the formal curriculum.
- **Students (6):** All student participants came from indigenous backgrounds. Their lived experiences and reflections on how IK is represented or absent within their academic journey provided critical insights into the effectiveness and relevance of integration efforts.
- **Administrators (3):** These participants included individuals in leadership or policymaking roles, such as deans, directors, or officers responsible for academic affairs and curriculum policy. They offered strategic-level perspectives on institutional commitments, policy frameworks, and administrative challenges.

The participants were selected using purposive sampling, a non-probability sampling method often used in qualitative research to intentionally select individuals who have firsthand knowledge of the phenomenon under investigation. This method is particularly appropriate for exploratory studies where the goal is to gain depth rather than breadth (Creswell, J. W. & Poth, C. N., 2016).

Table 1. Response rate

Respondent Category	**Number of Participants**	**Sampling Technique**
Faculty Members	6	Purposive Sampling
Students	6	Purposive Sampling
Administrators	3	Purposive Sampling
Total	**15**	

The Table 1 above categorizes the composition of the study's participants and their associated sampling method. The use of purposive sampling was grounded in the need to engage individuals with direct, experiential, and policy-related knowledge of IK integration processes. This method ensured that each selected participant had specific relevance to the study's core questions, rather than relying on random or representative sampling which may include individuals without adequate exposure to the subject. The faculty members brought a pedagogical

and design-oriented perspective. Their responses were crucial for understanding how IK themes are either integrated or overlooked in teaching materials, course syllabi, and instructional approaches. Through their narratives, the study uncovered both practical strategies and constraints within curriculum design that affect IK integration. The students, drawn from indigenous communities, provided grounded, firsthand accounts of their encounters with IK in academic settings. Their perspectives allowed the researcher to assess whether IK themes were present, meaningful, and empowering in their educational experiences. Their reflections also surfaced issues related to cultural validation, epistemic inclusivity, and curriculum relevance. The administrators provided the macro-level, institutional view. Their strategic role in decision-making processes meant they were key informants on how IK policies are framed, interpreted, and executed within the university's broader academic mission. This group also shed light on financial, structural, and policy constraints that shape or limit the university's ability to mainstream IK. This triangulated sample structure comprising curriculum designers, direct beneficiaries, and policy influencers ensured rich, layered data capable of revealing both horizontal (across stakeholders) and vertical (within institutional hierarchies) insights. This robust triangulation strengthened the study's credibility and allowed for a more nuanced analysis of the systemic and experiential dynamics involved in IK integration.

3.3 Data Collection Instruments

Three qualitative instruments were used to gather data:

1) **Semi-Structured Interviews:** These were conducted with faculty and administrators. The flexible interview guide allowed participants to explore themes freely while ensuring consistency across interviews. This approach provided detailed narratives about curriculum practices, challenges, and policy interpretations concerning IK.
2) **Focus Group Discussions (FGDs):** These were held with the six indigenous-background students. FGDs provided a safe, dialogical space for participants to collectively share their experiences. The group setting also allowed for the emergence of common themes, shared cultural interpretations, and validation of individual narratives.
3) **Document Analysis:** Institutional documents such as strategic plans, course outlines, curriculum frameworks, and policy manuals were examined. This analysis enabled the researcher to assess how IK is formally conceptualized in university policy and where gaps exist between policy intention and practical implementation.

By employing multiple instruments, the study achieved methodological triangulation, enhancing the credibility and dependability of the findings (Braun & Clarke, 2006).

3.4 Data Analysis and Interpretation

Data were analyzed using Braun and Clarke's (2006) thematic analysis framework, which involves six sequential phases:

1) **Familiarization:** Reading and re-reading of transcripts and documents to immerse in the data.
2) **Coding:** Identifying and labeling meaningful data features relevant to the research questions.
3) **Theme Development:** Clustering codes into coherent categories representing significant patterns.
4) **Theme Review:** Ensuring that themes are internally consistent and externally distinct.
5) **Theme Definition:** Assigning clear, concise labels to each theme and describing their essence.
6) **Narrative Synthesis:** Constructing a thematic report linking each theme to the study's objectives and theoretical framework.

This analytical process was iterative and reflexive, allowing themes to evolve through continued engagement with the data. The final themes reflected the core dimensions of IK integration as expressed by participants across all categories.

3.5 Presentation Style

Findings were presented thematically in narrative form, with each theme aligned to the study's research objectives. Verbatim quotes from participants were used to provide authenticity and richness to the analysis, while also respecting cultural nuances and the contextual grounding of each narrative. Institutional documents were used to validate or contrast participant claims, offering a layered presentation of findings that reflects both policy and lived realities.

4. Presentation of Findings

4.1 Indigenous Knowledge Integration Practices at Busitema University

The study found that Busitema University has made initial and modest strides toward integrating Indigenous Knowledge (IK) within its academic offerings, particularly in specific courses such as herbal medicine and environmental studies. These efforts, however, remain largely uncoordinated and are predominantly driven by the individual enthusiasm of select faculty members rather than being rooted in formal, institutionalized curricular frameworks. This results in IK integration being more incidental and localized rather than a systematic feature across the university's curricula.

One faculty member described this experience, noting:

"Our courses on natural products and pharmacology touch on indigenous medicinal plants, but beyond that, IK is not formally embedded in the curriculum. There is enthusiasm among some staff, but a lack of structured policy or dedicated modules. Integration feels more incidental than strategic — we sometimes include sections on traditional knowledge during lectures, but without formal recognition in the syllabus, it remains peripheral."

This perspective underlines the ad hoc nature of current IK inclusion, where indigenous knowledge is often presented as supplementary material rather than a formally recognized body of knowledge within the curriculum. The presence of IK depends heavily on individual lecturers' interest and expertise, leading to inconsistent student experiences.

Similarly, a student participant reflected:

"I appreciate when lecturers mention local herbal medicines or farming methods brought from my community. It makes learning relatable. But I feel this is not consistent across faculties. Sometimes it feels like IK is just added as an afterthought rather than being legitimized as knowledge equal to Western science."

This comment highlights the perceived marginalization of IK within the academic environment, where it is valued for its local relevance but frequently not afforded equal legitimacy compared to Western scientific knowledge systems. Such findings resonate with previous research emphasizing that sustainable and meaningful integration of IK in higher education requires structured institutional commitment, formalized curricula, and recognition of IK as a valid knowledge system on par with dominant academic traditions (Kaya & Seleti, 2013; Adyanga, F. A. & Romm, N. R. A., 2016; Paquin, 2023).

In the broader literature, successful IK integration models involve explicit curriculum frameworks, dedicated modules or courses, and active collaboration between indigenous communities and academic institutions to ensure respectful and authentic knowledge inclusion (Gabana, J. J., Claur, A. M. & Madrigal, D. V., 2025; UNESCO, 2002). The current practices at Busitema University, while promising, reveal a dependence on individual advocacy and a lack of university-wide strategic policy that limits the reach and legitimacy of IK in curricular offerings.

By and large, Busitema University exhibits a growing awareness and initial incorporation of Indigenous Knowledge in select academic disciplines. Nevertheless, the absence of formal policies and structured curriculum design places IK at risk of being perceived as peripheral rather than integral to education. Institutionalized frameworks, strategic policymaking, and comprehensive curricular inclusion stand out as crucial next steps to legitimize and sustain Indigenous Knowledge integration, ensuring that it is recognized as an essential knowledge system contributing to the university's educational mission.

4.2 Challenges Hindering Indigenous Knowledge Integration

The integration of Indigenous Knowledge (IK) at Busitema University is constrained by several significant challenges that are well-documented in academic literature and institutional reports. Key barriers include the slow pace of institutional reforms, lack of faculty preparedness to effectively teach IK, absence of formal policies or curriculum mandates, limited engagement with indigenous communities, and inadequate resources to support sustainable IK integration.

Institutional and policy gaps are paramount. An administrator at Busitema University noted the absence of explicit policies mandating Indigenous Knowledge integration, stating:

"One immense challenge has been the absence of explicit university policies mandating Indigenous Knowledge integration. Without clear directives, curriculum committees default to traditional Western academic content. Faculty also require training to handle IK pedagogically, which we have yet to systematically provide."

This reflects a critical structural barrier as the curriculum development process remains largely skewed towards Western academic paradigms in the absence of strategic university-wide IK policies.

Faculty competence presents another major hurdle. Effective IK teaching requires an understanding of indigenous epistemologies, including oral traditions, experiential learning, and intergenerational knowledge transfer mechanisms. A faculty member explained:

"Many lecturers are unfamiliar with pedagogy appropriate for IK how to teach oral traditions, practical skills,

and community-centered knowledge. This complicates integration efforts, as standard academic formats don't always fit indigenous epistemologies."

This confirms findings in broader scholarship highlighting that conventional Western academic teaching methods are often incompatible with IK's nature and delivery styles (UNESCO, 2002; Gabana, J. J., Claur, A. M. & Madrigal, D. V. 2025). Faculty capacity-building tailored to these distinct teaching methods remains largely undeveloped at Busitema University.

Another critical challenge is limited collaboration with indigenous knowledge holders and communities. Authentic IK integration necessitates partnerships that respect indigenous custodianship and facilitate co-creation of curricula and research agendas. Although Busitema University actively engages with traditional herbal practitioners and has hosted significant events such as the Herbal Medicine Exhibition for Eastern Uganda (June 2025) to bridge traditional knowledge holders with scientific researchers, these initiatives are recent and have yet to be institutionalized for sustained impact (Busitema University News, 2025). Expanding such engagements is essential to ensure IK is incorporated with cultural sensitivity and legitimacy.

Resource constraints further exacerbate integration difficulties. Dedicated funding, infrastructural support, and development of culturally relevant teaching materials are needed to institutionalize IK. Programs like the Natural Products Research and Innovation Centre (NaPRiC) at Busitema University emphasize scientific validation of herbal medicines, supporting IK through research grants and partnerships. However, broader resource allocation across faculties remains limited (NaPRiC Concept Note, 2024). This reflects a common challenge in African universities where budgetary and infrastructural support for IK initiatives lags behind ambitions (Kaya & Seleti, 2013; Adyanga, F. A. & Romm, N. R. A., 2016).

These challenges mirror those established in peer-reviewed studies on IK integration in higher education across Africa, which stress that without formal policy frameworks, faculty development, community partnerships, and sufficient resources, integration remains fragmented and unsustainable (Paquin, 2023; Gabana, J. J., Claur, A. M. & Madrigal, D. V. 2025).

In conclusion, the main challenges at Busitema University hindering Indigenous Knowledge integration are closely aligned with global and regional scholarly insights: absence of formal institutional policies, lack of pedagogical competence in IK-specific teaching methods, limited indigenous community collaboration, and insufficient dedicated resources. Addressing these requires strategic institutional reforms including policy enactment, targeted faculty training, strengthened community engagement, and allocation of resources to move from isolated faculty initiatives toward systematic and sustained inclusion of Indigenous Knowledge in the university's academic landscape.

4.3 Strategies to Enhance Indigenous Knowledge Integration

Respondents at Busitema University recommend several strategic approaches to improve the integration of Indigenous Knowledge (IK) within the university's curricula and teaching processes. Central to these recommendations are the development and enforcement of formal institutional policies that mandate IK inclusion across all academic programs. Faculty capacity building through targeted, ongoing training workshops tailored to IK pedagogy is highlighted as vital to equip lecturers with skills to effectively teach indigenous epistemologies.

A faculty member succinctly captured this necessity:

"Institutional policies must compel us to integrate IK. We need workshops and resources to build our capacity on IK pedagogy. Moreover, involving community knowledge holders as co-educators can enrich curricula and foster respect for indigenous epistemologies."

This speaks to the dual requirement of top-down policy frameworks and bottom-up faculty empowerment to ensure IK is systematically and authentically embedded in teaching.

In addition, respondents emphasize establishing genuine partnerships with indigenous knowledge holders and elders to involve them as co-educators and contributors within the learning environment. This reciprocal engagement helps preserve the authenticity of IK representation and enhances students' cultural pride and cognitive connection to their heritage.

A student's perspective reinforces this point:

"*Involving elders and local experts in teaching sessions would make IK more authentic and alive. This partnership approach would also build student pride and confidence in their cultural heritage."*

These recommendations closely align with peer-reviewed literature and reports from other African higher education contexts. For instance, Magara, E. (2015) and Kaya & Seleti (2013) argue that effective IK integration necessitates institutional policies, community collaboration, and faculty training in culturally appropriate

pedagogies. The Association of Indian Universities' recent Faculty Development Program on integrating IK into curricula similarly underscores policy support, faculty development, and community partnerships as critical pillars (Pani, A., House, A. I. U. & Marg, C. I. G., 2024).

Further, Gabana, J. J., Claur, A. M. & Madrigal, D. V. (2025) emphasize interdisciplinary and cross-sectoral learning approaches, encouraging the creation of dedicated modules or flexible curriculum spaces to accommodate IK content. UNESCO (2002) identifies the documentation and co-development of teaching resources with indigenous communities as a crucial strategy to sustain IK pedagogy.

By embracing a strategy that combines formal policy frameworks, continuous faculty capacity-building, respectful community collaboration, and interdisciplinary curriculum design, Busitema University can enhance the authenticity, comprehensiveness, and sustainability of Indigenous Knowledge integration, ultimately contributing to decolonizing education and improving its cultural relevance.

5. Discussion

The gradual inclusion of Indigenous Knowledge (IK) in Busitema University's curricula reflects broader trends observed in African higher education, where policy recognition of IK often precedes substantive curricular integration. Makokotlela and Gumbo (2025) observe that many African universities are still in early stages of embedding IK formally, resulting in fragmented and largely individual-driven efforts. Busitema University's experience of sporadic IK inclusion, primarily led by enthusiastic faculty without a cohesive institutional framework, exemplifies this pattern. This underscores the critical need for explicit institutional policies and mandates to move from sporadic gestures toward systematic, consistent integration of IK across programs.

Barriers to IK integration identified at Busitema University confirm key themes in scholarly research on epistemic marginalization, inadequate faculty preparedness, and policy gaps (Seleke, 2025). These systemic issues hinder the authentic inclusion of IK and perpetuate the dominance of Western knowledge traditions. As Ryan, J. & Ivelja, J. (2023) highlights, the epistemic marginalization of IK is often institutionalized through curricular structures that favor Western scientific paradigms. Faculty members' unfamiliarity with pedagogies suited to IK further exacerbates the challenge, reflecting wider calls for culturally responsive teaching methods (Seleke, 2025). The absence of formal policies and systemic supports reinforces the marginal position of IK, necessitating university-wide structural responses rather than relying on isolated, individual innovation.

The strategies proposed by respondents to enhance IK integration formal policy development, faculty capacity building, community engagement, and promotion of interdisciplinary learning are consistent with international best practices documented in peer-reviewed literature. Barnhardt and Kawagley (2005) emphasize collaborative curriculum reform and inclusion of indigenous knowledge holders as co-educators to ensure meaningful integration. Similarly, Jilcha et al. (2022) advocate for faculty professional development and authentic community partnerships as keys to sustaining IK in academia. This multi-stakeholder approach, combining policy, pedagogy, and partnership, provides a viable pathway for Busitema University and comparable institutions aiming to decolonize curricula and legitimize IK alongside dominant academic traditions. These discussions collectively reveal that while Busitema University is beginning to embrace IK, achieving transformative integration will require aligning policy frameworks, faculty development, and community collaboration, reflecting a growing consensus in African and global scholarship on Indigenous Knowledge education.

6. Conclusion

Busitema University's effort to integrate Indigenous Knowledge (IK) into its academic environment marks an important but currently limited shift toward educational pluralism. The university's initiatives, mainly concentrated in areas like herbal medicine and environmental studies, demonstrate initial recognition of IK's value for contextualized learning and local innovation. However, this integration remains fragmented and is not yet embedded within a university-wide framework. The absence of formal institutional policy leaves IK initiatives dependent on the enthusiasm and competencies of individual faculty, leading to inconsistent student experiences and often relegating IK to supplementary rather than core status.

Faculty often lack specialized training to effectively teach IK, which demands unique pedagogical approaches suited to oral traditions, community-based teaching, and experiential knowledge transmission. Without systematic faculty development, lecturers tend to rely on conventional Western academic formats, which may not fully capture or respect the integrity of indigenous epistemologies (Kaya & Seleti, 2013; Adyanga, F. A. & Romm, N. R. A., 2016). Moreover, weak and sporadic collaboration with indigenous communities limits the authenticity and sustainability of IK integration, as community elders and knowledge holders are central to the transmission and validation of indigenous wisdom.

These challenges reflect broader patterns observed in African higher education, where policy recognition of IK often precedes practical curricular transformation (Makokotlela & Gumbo, 2025). Restrictions such as policy

absence, limited faculty capacity, and insufficient community partnerships hinder the institutionalization of IK at Busitema University and restrict its potential to transform higher education into a more culturally relevant and epistemically pluralistic system.

7. Recommendations

Universities should Develop and Adopt Formal IK Integration Policies: The university should create comprehensive policies that explicitly mandate and support the inclusion of IK throughout its academic offerings. This would formalize the value of IK within curriculum committees, provide clarity and guidance, and ensure its recognition across all faculties and programs in a way that moves beyond isolated, discipline-specific efforts (Makokotlela & Gumbo, 2025; Kaya & Seleti, 2013). Likewise, they should establish Continuous Faculty Training on IK Pedagogy: Sustained faculty professional development is needed to equip lecturers with pedagogical tools for teaching IK. Workshops should address how to integrate oral histories, practical skills, and collaborative knowledge production into coursework, aligning teaching methods with the unique characteristics of IK (UNESCO, 2002; Gabana, J. J., Claur, A. M. & Madrigal, D. V., 2025). They should also Institutionalize Partnerships with Indigenous Communities: The University should develop formal channels for partnership with indigenous communities, inviting elders and knowledge holders to participate directly as co-educators and curriculum advisers. This collaboration ensures IK is represented authentically and builds students' cultural pride while respecting indigenous intellectual property (Adyanga, F. A. & Romm, N. R. A., 2016; Gabana, J. J., Claur, A. M. & Madrigal, D. V., 2025). They should Allocate Dedicated Resources: Targeted annual budgeting is needed for IK curriculum development, teaching materials, faculty training, and partnership-building activities. This should include support for research and innovation centers like the Natural Products Research and Innovation Centre (NaPRiC) at Busitema, which already promote the validation and application of traditional medicinal knowledge.

All universities should Create Collaborative Networks: Build inter-university platforms for sharing IK integration models, teaching resources, and research outputs. This would reduce duplication, accelerate innovation, and build best practices tailored to local contexts (Adyanga, F. A. & Romm, N. R. A., 2016). Co-Develop Interdisciplinary IK Resources: Engage faculties of agriculture, public health, education, and natural sciences in joint development of teaching modules and materials that reflect the cross-cutting nature of indigenous knowledge (Paquin, 2023). Advocate for National Curricular Frameworks: Universities should proactively collaborate to lobby regulatory bodies for clear, enforceable standards on IK inclusion in higher education.

National Council for Higher Education (NCHE): Mandate IK Inclusion Standards: Set clear and mandatory requirements for the inclusion of IK in tertiary curricula, pushing universities to move beyond voluntary adoption. Fund Faculty Capacity Initiatives: Provide grants for faculty development, particularly for the design and delivery of IK-focused courses, and incentivize research that explores effective IK integration (Gabana, J. J., Claur, A. M. & Madrigal, D. V., 2025). Monitor and Evaluate Implementation: Regularly review and report on institutional progress in IK integration to ensure accountability and guide continuous improvement.

Education Policymakers: Develop National Guidelines: Establish policy instruments recognizing the legitimacy and importance of IK in higher education, setting benchmarks for curriculum content and delivery (UNESCO, 2002). Support Community-Academic Platforms: Fund and facilitate knowledge exchange events, workshops, and digital platforms that bring together academics, indigenous experts, and students. Incentivize Innovative Research: Encourage pedagogical research that documents best practices and outcomes in IK teaching and learning.

Ugandan Government: Promote IK Protection in Policy: Affirm IK as a core value in national education law and strategy, with explicit language on its preservation and promotion. Fund Research Centers for IK: Allocate national research funds to expand centers like NaPRiC and establish new ones, supporting comprehensive IK documentation and curriculum development. Facilitate Intellectual Property Rights: Create frameworks that protect the rights of indigenous knowledge holders and ensure cultural resources are not exploited without proper recognition or benefit-sharing (Paquin, 2023).

In summary, the meaningful and sustainable integration of Indigenous Knowledge at Busitema University and across Uganda's higher education sector demands aligned action across policy, pedagogy, and partnership. With stronger institutional commitments, capacity-building, and respectful community engagement, Busitema can move from isolated initiatives to making IK a living, respected, and essential component of knowledge production and transmission.

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