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An Assessment of Modular Learning in Higher Education: A Case of a University in Zimbabwe.

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Abstract

The aim of the study was to assess the implementation of the modular learning approach in an institution of higher learning from the student's perspective. The study was a case of a mathematical sciences department at a university in Zimbabwe. One hundred and twenty-three students registered to study for degree programmes in mathematical sciences participated in the study. The participants were selected using stratified sampling. The results of the study revealed that the students felt that the approach was student sensitive in that it allowed them to balance school, work and family. However, the students felt that they were not getting enough learning assistance. They complained of shortage of learning materials. They also felt that they were not actively involved in curriculum design. The researchers recommended that the department ensure that the students receive regular, timeous, constructive and motivating feedback. Self and peer assessment was necessary. Field trips and practical learning activities could help to give the students first-hand learning experience.

Keywords: continuous assessment, modular learning, outcome-based, student-centred.

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1. Introduction

The modular learning, an outcome-based learning approach has gained popularity in institutions of higher learning in Zimbabwe. As the focus in higher institutions of learning is gradually shifting from teaching to learning, most universities in Zimbabwe have transformed their modes of instruction from traditional ways of teaching to blended modular learning.

According to Dejene (2019), modular learning involves breaking the curriculum into discrete short-term units or modules. The modules are usually independent and non-sequential. Each module contributes towards the total number of credits required for a student to graduate in a specific area of specialisation. Tate, Schubert and Mccoy (2014) described modular learning as a student-centred, andragogic approach that supports individualised learning by providing opportunities for students to choose modules that best suit their specific areas of specialisation.

Institutions of higher learning in Zimbabwe introduced the modular system of learning during the time when the Covid-19 pandemic had hit the country (Gora, 2023). During this time, traditional methods of learning became less plausible hence, there was need to transform the learning system from the traditional brick and mortar classroom to blended computer aided learning. Although the pandemic triggered the immediate introduction of modular learning, the need to meet the demands of the fourth industrial revolution education policy known as the Doctrine Education 5.0 also necessitated the introduction of modular learning in Zimbabwe's institutions of higher learning (Gore, Kulkarni & Suasane, 2023). Doctrine Education 5.0 emphasises on education that aims to improve teaching, research, community service, innovation and industrialisation. The doctrine is a shift from traditional modes of learning that were deemed to be producing workers and not employers to modern technology aided methods that emphasised on creativity, critical thinking and problem solving. Its aim is to address the needs of the nation through imparting students with skills and knowledge that enhance the production of the much-needed goods and services. Therefore, the best graduate is one who can apply the content learnt in solving societal problems. Emphasis is on the learning outcome and not on the learning itself.

In implementing modular learning in Zimbabwe, the semester is broken into four blocks. In each block, students register for one or two modules. At the end of the block, the students sit for exams for the modules registered.

This system has been in place for over four years in Zimbabwe. However, a review of the available literature shows lack of research to assess the benefits and challenges of modular learning to the students. The only study found in the reviewed literature revealed that in Zimbabwe, stakeholders in higher education received modular learning with mixed feelings (Gora, 2023). Gora reported that those in leadership felt that the approach helps in retaining students and improving pass rates. Lecturers complained of overloading and students felt that it was an opportunity for them to balance between family and school since the system allows them to work whilst they learn. In order to contribute to the scant literature, the current researchers, as mathematics lecturers thought of carrying out a study to assess modular learning from the mathematical sciences students' perspective. The study was guided by the following research questions:

- How is the department of mathematical sciences implementing modular learning?
- What are the benefits of modular learning to Mathematical Sciences students?
- What are the challenges faced by the Mathematical Sciences students during modular learning?

2. Conceptual framework

The modular learning model is based on four major principles, which are student centeredness, outcome based, individualised learning and continuous assessment (Dejene, 2019). **Figure 1** illustrates the four principles of modular learning

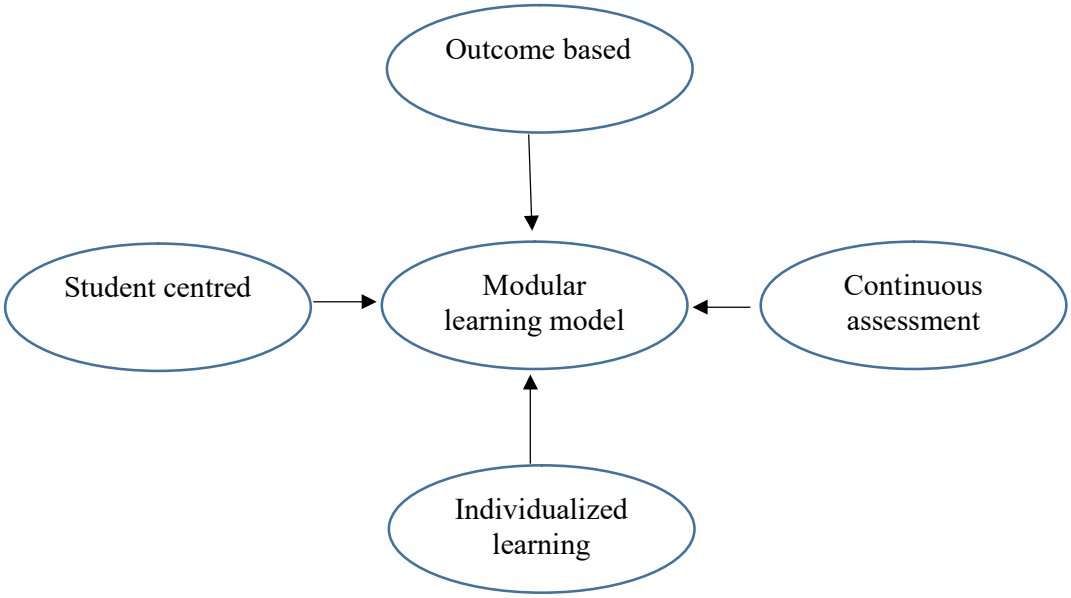

Figure 1. Principles of modular learning.

2.1 Student centeredness and individualised learning

Modular learning is personalised learning in the sense that it is characterised by existence of diverse variety of modes of learning, learning support services and choice of courses that are meant to meet the distinct needs of the learners. The needs and abilities of individual learners determine the choice of modules and pace of learning (Vallespin, 2021). In short, modular learning is not a one-size-fits-all type of learning. It takes into account the individual differences of the learners (Dejene, 2019). According to Lindner and Schwab (2020), it is a response to the heterogeneity of the students and it ensures inclusivity and participatory fairness in the learning system. Although individual differences are taken into consideration, modular learning uses a self-learning style in which the student participates actively in the learning process and the teacher takes the role of a facilitator (Hoidn & Reusser, 2020). This demands some degree of maturity, self-discipline and self-management on the part of the learner. The curriculum allows the students to interact with peers, experts, professionals, entrepreneurs and any other relevant stakeholders. Students get opportunities to display their creativity, critical thinking, problem solving and innovation skills.

2.2 Outcome-based Learning

According to Ali et al (2010), modular learning moved the curriculum from the supply side to the market side. This meant that the institutions of learning shifted the emphasis of learning from what they wanted to teach the learners to what the students and the society needed. The learning curriculum is designed with the needs of the society in mind. Modular learning is outcome-based education (OBE). Bhat (2018) defined outcome-based education as a student centric type of learning that promotes lifelong learning by focusing on what the students should be able to do after graduating. According to Bhat, outcome-based learning is not prescriptive and can take place in a non-sequential manner with the teacher being accountable for the students' outcomes. The main aim of outcome-based education is to increase the students' employability.

2.3 Continuous assessment

In a modular learning system, continuous assessment plays a pivotal role. Continuous assessment is the assessment of the on-going progress of a student towards attainment of the intended outcomes of a particular learning module. The assessment can be either formative or summative. Both forms of assessment are critical as they enable the instructor to make decisions on the grading of the student's performance. Effective assessment and constructive feedback given timeously promote effective learning. Formative assessment is done during the process of learning. According to Garcia et al (2010), formative assessment supports the learner during the learning process while summative assessment validates the achievement of the intended learning outcome. Isaksson (2007) suggests that continuous assessment allows students to review their learning and in so doing, it motivates them to learn. Rushton (2005) supports this by saying that regular feedback given during continuous assessment enhances effective learning. In the context of modular learning, continuous assessment should be done in accordance to the learning outcomes of the modules. It should reflect attainment of expected learning and show the extent of mastery of learnt concepts. In order to avoid over burdening the students, the timetable for assessment should be planned and be shared with the students in advance (Dejene, 2019).

3. Assessment of modular learning in other countries

Dejene (2019) assessed how institutions of learning in Ethiopia implemented the modular learning approach. The participants were students and lecturers. Dejene observed that although the approach demanded that the learning process be learner centred, in the case of the institutions in Ethiopia it was still mostly teacher centred. The teachers used traditional lecture method with the assistance of PowerPoints. This was due to large class sizes and short learning periods. Students were dormant participants in the learning process. Continuous assessment, in the form of tests, was done but feedback was rarely given to the students in time. The teachers viewed group assignments as a way of supporting slow learners so that they pass and not as a way of sharing ideas. Students felt that they were overloaded. Thus, the researcher concluded that there was need for improvement on the implementation of the approach.

In Philippines modular learning was introduced during the Covid-19 pandemic by the county's Department of Education (Yes, 2022). During the time, the students in the country could hardly attend school physically due to the covid-19 induced lockdown. The students learnt through print and digital material. Their assessment was through emails, text messages, instant chats and telephones. Desabayla, Deri and Cantuba (2023) reported on a number of positive points on the implementation of the modular learning system. They observed that continuous assessment of the students was effectively done. According to the researchers, the learning approach was student and time friendly. Students saved time and money through limited travel to and from school. However, the researchers also noted some challenges related to the approach. The challenges included lack of reliable internet, inadequate learning resources, overloading of students, mental health problems, poor learning environment, inadequate learning resources and lack of socialisation (Bustilo & Aguilos 2022).

4. Materials and methods

The current research was a case study of a mathematical sciences department at a university in Zimbabwe. The study followed a mixed methods approach. The approach enabled a deep understanding of the implementation of modular learning in the department. One hundred and twenty-three students officially enrolled at the university for Mathematical Sciences degree programmes (Data Science, Applied Statistics, Financial Mathematics, Actuarial Science and Mathematics) participated in the study. The researcher selected the participants using stratified sampling. The sample comprised seven postgraduates and one hundred and sixteen undergraduates.

The researcher collected data using an online questionnaire. The online questionnaire had two sections. The first section required the students to provide ratings on the statements to do with the implementation of the modular learning system in the department using a Likert scale from 1 to 5 (1-stongly disagree, 2-disagree, 3-neutral, 4-agree, 5- strongly agree). The second section sought the students' views on the benefits and challenges of the modular learning system.

Both qualitative and quantitative data were collected. Qualitative data was categorised according to the emerging themes and was analysed using content analysis. Quantitative data was analysed using descriptive statistics and Friedman's Chi-square statistic derived from Kendall's coefficient of concordance. Friedman's Chi-square statistic (at 5% level of significance and with $(k-1)$ degrees of freedom) determined the participants' level of agreement in the ratings on the statements describing the ways in which modular learning was being implemented. The formula used to calculate the Friedman's Chi-square statistic was as follows:

$$X^2 = m(k-1)w \quad (1)$$

where m is the number of participants who rated the statements and in the study m was equal to 123. k is the number of statements rated by the participants and w is the Kendall"s coefficients of concordance calculated as

$$w = \frac{12s}{m^2(k^3-k)} \quad (2)$$

Also s is the sum of squares of the ratings awarded to each statement by the participants. The formula for s is

$$s = \sum_{i-1}^{k}(r_i - \bar{r})^2 \quad (3)$$

where r_i refers to the sum of the ratings assigned to the i^{th} statement and $\bar{\bar{r}}$ is the mean of r_is. The calculations were done using excel 2016 version.

5. Results

5.1 Students' assessment of the student centeredness of the implemented modular learning system

Table 1 shows the descriptive statistics on the ratings awarded by the students to the statements concerning the student centeredness of the implemented learning approach.

Table 1. Students' ratings of the statements on the student centeredness of the implemented modular learning system

Statement	Mean rating	Standard deviation
Flexibility for students in choosing modules	3	0.8
Flexibility for students in determining time and period of study	4	1.1
Availability of supportive learning materials	2	0.8
Active participation of students in the learning process	4	1.1
Opportunity for students' peer tutoring	3	1.2
Availability of timeous mentorship or learning guidance	3	1.2
Opportunity to carry out practical activities like projects and research	2	0.8
Involvement in curriculum design	2	1.4
Opportunity to set own study objectives	3	0.8
Availability of computer aided learning facilities like internet, journals and library	4	0.6
Availability of blended learning facilities (face-to-face and online)	3	0.9
The workload fits the students' circumstances	4	1.1
The learning process is generally student self-driving	3	0.6

The ratings awarded by the students revealed that most of the students agreed that the modular learning system was flexible in terms of time and period of study. They also felt that they were actively participating in the learning process and the work was flexible enough to suit their circumstances. This was shown by a mean rating of 4 awarded by the students to these aspects on the questionnaire. However, the standard deviations were moderately high on these aspects. This shows that there were some huge variances in the ratings among the students. The students also rated the availability of computer aided learning facilities high. Most of the students agreed on this aspect as shown by the low standard deviation (0.6).

A mean rating of 2 shows that the students felt they were not being fully involved in curriculum designing. The students awarded the same mean rating (2) to the availability of supporting learning materials and opportunity to carry out practical activities. However, some differences existed on how the students felt in terms of their involvement in curriculum design since the standard deviation obtained was a bit high.

A neutral score of 3 was the mean rating on the flexibility of the system in allowing students to choose modules, availability of peer tutoring opportunities, availability of blended learning facilities, availability of learning assistance and facilitation of students in setting their own study objectives. The standard deviation on these aspects were low (less than one) except on availability of peer tutoring and mentorship.

In order to test whether a statistical concordance existed among the students' ratings on the student-centeredness of the implemented modular learning system, the researchers tested the following null hypothesis using Friedman's Chi square test:

> H_0: *There is no agreement among the students on their ratings on the student centeredness of the implemented modular learning system*

Table 2 shows the summary statistics from the Friedman's Chi-square test on the student centeredness of the modular learning system.

Table 2. Friedman's Chi-square test summary statistics on the students' ratings of the student centeredness of the modular system.

w	X_{cal}^2	$d.f$	$p-value$	X_{table}^2	α
0.256	377.75	12	0.00	21	0.05

$w = kendall's\ coeficient\ of\ concordance$ $X_{cal}^2 = test\ statistic$ $d.f = degrees\ of\ fredom$

$p.value = probability\ value$ $X_{table}^2 = chi-square\ table\ value$ $\alpha = siginificance\ level$

The p-value (0.00) was less than the significance level (0.05) and the test statistic was greater than the table value therefore the null hypothesis was rejected. The conclusion was that there was evidence at 5 % level of significance to show that there was concordance in the students' ratings.

5.2 Students' assessment of the outcome-based nature of the implemented modular learning system

Table 3 shows the descriptive statistics of the ratings awarded by the students to the outcome-based nature of the modular learning system implemented in the mathematical sciences department.

Table 3.Students' ratings on the outcome-based nature of the implemented modular learning system

Statement	Mean rating	Standard deviation
Opportunity to set own outcomes or goals	2	1.6
Availability of problem-based learning	3	1.1
Opportunity for field trips and practical learning	1	0.4
Availability of work-related learning opportunities	5	0.5
Opportunity for showing creative ideas	3	1.3
Innovation and industrialisation part of learning	5	0.7
Study material supports innovation and industrialisation	2	0.4
Modules are self-containing	4	1.2
Assessment is based on the accomplishments	4	0.8

Availability of work-related learning and inclusion of innovation and industrialisation concepts in the learning modules were highly rated by the students with low standard deviations indicating an agreement among the students on these aspects. The students also agreed that they were assessed on their accomplishments and their modules were self-contained and non-sequential. However, the standard deviation on the non-sequential and self-containing nature of the modules was a bit high (1.2) indicating some variances in the ratings.

The students strongly disagreed that they got an opportunity to go for field trips and practical learning activities. The standard deviation of the ratings on this aspect was very low (0.4) indicating that the students agreed. They also disagreed that the system allows them to set their own goals and that the study material supports innovation and industrialisation. The mean rating on these aspects was 2.

The participants awarded a mean rating in the neutral class (3) to the ability of the implemented learning system to allow students to display their creativity and problem-solving skills. However, huge variances in the ratings were observed as shown by the high standard deviations.

The researchers tested the students' agreement on their ratings of the outcome-based nature on the implemented modular learning system. The null hypothesis tested was as follows:

> H_0: *There is no agreement among the students on their ratings on the outcome-based nature of the implemented modular learning system*

Table 4 shows the summary statistics from the Friedman's Chi-square test on the students' ratings on the outcome-based nature of the implemented modular learning system.

Table 4. Summary statistics from the Friedman's Chi square test on students' ratings on the outcome-based nature of the implemented modular learning system

w	$\tilde{X_{cal}}$	$d.f$	$p-value$	$\tilde{X_{table}}$	α
0.2297	226.02	8	0.00	15.5	0.05

The p-value was less than the significance level therefore the null hypothesis was rejected. The researchers concluded that the students were concordant in their ratings of the statements.

5.3 Students' assessment on the implementation of continuous assessment

Table 5 shows the descriptive statistics of the ratings awarded by the students to the statements on the implementation of continuous assessment.

Table 5. Descriptive statistics on the students' ratings on the implementation of continuous assessment.

Statement	Mean rating	Standard deviation
Modules provide opportunity for self-assessment	1	0.8
Modules provide opportunity for peer assessment	1	0.8
Availability of clear learning instructions	4	1.1
Continuous assessment criteria known to students	4	0.8
Regular feedback and updates on performance provided in time	3	1.1
Feedback is constructive and motivating	2	1.3
Assessment of practical work, logs, diaries and portfolios done	3	1.3
Continuous assessment of work-related learning is effectively done	4	0.7
Aims and outcomes of learning modules are clearly given	3	0.8
Continuous assessment assesses knowledge and skills	3	1.2
Assessment is done though out the course of learning	4	1.3
Continuous assessment is done regularly	2	1.1
All assessments count to the final mark	5	0.6
In-course assessments indicate the student's performance	5	0.7
Assessments enable the student to monitor own progress	4	1.2
Assessment enables the student to close existing learning gaps	3	1.1

The results indicated that the students strongly agreed that their in-course assessments indicate their performance and all the assessments done count to their final marks. An agreement among the ratings was shown by the low standard deviations obtained (0.6 and 0.7). The students agreed that the learning instructions and criteria for assessment were clear. They also agreed that continuous assessment including assessment of work-related learning was done throughout the course of learning.

However, the students strongly disagreed (mean rating 1) that the modules afforded them an opportunity for self and peer assessment. They also disagreed that regular, constructive and motivating feedback was given to them.

A neutral mean rating (3) was awarded to timeous feedback, existence of clear module aims, assessment of skills and knowledge as well as the ability of the continuous assessment to enable the students to close learning gaps. However, huge variances were observed, as shown by the high standard deviations (all above one), on these aspects indicating mixed feelings among the students.

The following hypothesis was tested in order to ascertain if there was concordance in the students' ratings on the implementation of continuous assessment.

> H_0: *There is no agreement among the students' ratings on the implementation of continuous assessment*

Table 6 shows the summary statistics from the Friedman's Chi-square test on the students' ratings on the implementation of continuous assessment

Table 6. Summary statistics on the Friedman's Chi square test on the students' ratings on the implementation of continuous assessment

W	$\bar{X}_{cal}$	$d.f$	$p-value$	$\bar{X}_{table}$	α
0.047	92.72	16	0.00	26.3	0.05

The results lead to the rejection of the null hypothesis since the p-value was less than the significance level. The conclusion was that there was an agreement among the students on their ratings on the implementation of continuous assessment.

5.4 Reported benefits from the implemented modular learning system

According to the participants, the modular learning system benefited them in a number of ways. **Table 7** shows the ways in which the students benefitted from the learning system and the number of students who mentioned the benefits.

Table 7. Benefits of the modular system of learning to the students (n=123)

Benefits	**Frequency**	**%**
Enhances deeper understanding as students concentrate on a small area of learning at a time	104	85
Serves time and money by reducing travelling to and from school	92	75
Allows students opportunities to borrow modules from other programmes	81	66
Enables self-sponsoring as students can attend both school and work (remedy to increased cost of education)	103	84
Enables a balance between school and other activities	50	41
Enables students to study on part-time basis	22	18
Caters for students' varying goals, interests and learning styles	100	81
Promotes self-control, self-pacing, self-management and improved sense of responsibility	63	51
Increases employability	38	31

Among other benefits mentioned by the students as shown in **Table 7,** was that there was a common observation by the students that the system allows them to concentrate on a small area of learning at a time thereby enabling them to get a deep understanding of the learnt material. Most of them also observed that the learning approach caters for the varying needs of the students and it allows them to sponsor themselves as they can attend to both school and work.

5.6 Challenges faced by the students in the modular learning system

Although there were some benefits associated with the modular learning system, the students also highlighted some challenges associated with the implemented learning system. **Table 8** shows the challenges observed by the students.

Table 8. Challenges faced by the students during the modular learning system (n=123)

Challenge	Frequency	%
Short learning period	71	58
Too much pressure on the student due to lack of time	92	75
Limited or delayed feedback from the tutors	36	29
Shortage of essential learning resources	73	59
Limited internet connectivity	57	46
Non availability of experts or resource persons in some learning areas	14	11
Lack of or absence of assistance in learning	97	79

The major challenges mentioned by the students were lack of assistance in learning, shortage of relevant learning materials and too much pressure caused by lack of time.

6. Discussion

The results of the research shows that the students were in agreement in the way they rated the implementation of the modular learning approach by the Mathematical Sciences department. They students agreed that they had an opportunity to determine their pace and time of study and were actively participating in their learning process. This was in line with the principles of the modular learning approach as mentioned by Dejene (2019). However, the students complained of lack of assistance in their learning. Dejene observed the same challenge in Ethiopia and it was attributed to large classes and short study time. The current researchers thought that maybe the students were failing to understand that the role of the lecturers or tutors in the modular learning system is to facilitate learning as stated by Hoidn and Reusser (2020). In the current study, the students complained of limited time of study. They felt that the time allocated to their modules led to overloading on their part. In Philippines, Bustilo and Aguilos (2022) also identified overloading as one of the challenges faced by students in a modular learning system. O'neil, Moore and McMullin (2005) suggested that the designers of a modular learning system should ensure that overloading is minimised. Despite overloading, the students in the current study appreciated that the system allowed them to perform other activities that assisted them in sponsoring themselves towards their studies. In addition to self-sponsoring, they were also able to save money through reduced travel to and from school. Desabayla, Deri and Cantuba (2023) also raised the same point in their report on an assessment of the modular learning system in Philippines. Although the students who participated in the current study appreciated the availability of computer aided learning materials, they complained of poor internet connectivity and lack of other learning materials that could fully complement a blended learning system. The researchers observed that the challenge was not unique to the department as the same complain was raised by students in Philippines as reported by Bustilo and Aguilos (2022) as well as by Desabayla, Deri and Cantuba (2023). Although the reviewed literature did not mention field trips and practical learning activities, the participants in the current research reported that they failed to get an opportunity to participate in field trips and practical learning activities. The researchers felt that these activities were important in the modular learning system as they assist in achieving the aims of outcome-based education by giving the students first-hand experience.

7. Conclusion and recommendations

Based on the results of the study, the researchers concluded that the Mathematical Sciences department implemented some and not all the principles of the modular learning approach. The department took into consideration the varying needs of the students. The students appreciated some benefits of the learning approach. However, they were facing some challenges with the modular learning system. In order to overcome the reported challenges, the researchers recommended that the system be improved by ensuring that the students get regular, timeous, constructive and motivating feedback on their work. The department should allow self and peer assessment by the students. There was need to provide the students with reliable and efficient internet connectivity so that they could access learning material online. Apart from improved internet, the university

should also avail other learning materials that help in facilitating active learning. Field trips and practical learning activities were also very essential as they help in facilitating active learning.

8. Acknowledgements

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9. Declaration of interest

The researchers do not have any conflict of interest pertaining the study.

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