



Assessment of First-Year Students' Prior Knowledge as a Pathway to Student Success: A Biology Based Case

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Abstract. This study assesses students' prior knowledge as a pathway to ensuring improvements in student academic success. It is noted that a widespread problem faced by lecturers in institutions of higher learning is that students lack significant prior knowledge and skills required to circumvent challenges they encounter when faced with more advanced subject matters in the curriculum. A survey questionnaire was uploaded on the Moodle LMS of Biology module to solicit the difficulties and challenges in Biology subject content that require meticulous attention. Hundred and eighty-six (186) students enrolled in the academic year 2022 of the extended degree programme participated in this study. Therefore, a mixed method was employed to solicit the descriptive and numerical data for critical analysis, and a thematic analysis technique was employed for qualitative data. Furthermore, the findings of the current study acknowledge the benefits and significance of students' prior knowledge consideration to successful academic achievements. The key contributions of this study seem to suggest the consideration of students' prior knowledge expedites the detection of at-risk students, initiative-taking techniques after the assessment tasks, and intervention strategies that there are effective for enhancement of students' academic success. This technique enabled the lecturers to assess what students know, such that they can strategically allot time to the areas of the greatest need. This paper recommends that the pre-existing knowledge should be integrated with the updated content to expedite the students' understanding of the subject and identify misconceptions in the module content.

Keywords: Academic Success · Genetics · Students' knowledge · Interventions · Moodle · Teaching strategies

1 Introduction

This is a growing and competitive area of research since the integration of prior knowledge and new knowledge tends to alienate the students who have been a product of previously disadvantaged schools. A frequent problem faced by lecturers in institutions of higher learning is that students lack significant prior knowledge and skills required to circumvent challenges they encounter when faced with more advanced subject matters in

the curriculum [1]. Lack of this does not only impact the students' learning negatively [2]; however, there is a compromise in the achievement of learning outcomes due to a lack of prior knowledge considerations. Prior knowledge is a dynamic, multidimensional, hierarchical entity consisting of types of knowledge and skills [3–5].

On the other hand, prior knowledge continued to be essential to active learning and successful student achievement [6]. Most significantly, prior knowledge is indispensable in addressing inadequate or fragmented lecturers' expectations of student knowledge and the student's actual knowledge [2]. The mismatch between the lecturer's expectations and the student's actual knowledge hampered learning from the onset [2]. As van Riesen et al. [7] elucidated, prior knowledge helps to decrease complete habitual memorization resulting in good learning performances and achievements.

A successful teaching and learning practice should have lecturers who care for students and are considered good teachers because they are believed to be caring [8]. As a result, students who view their lectures as caring provide reports of enjoyment of school and motivation for successful learning. Other authors elucidate a significant connection between students' emotions and academic achievement [9]. As stipulated by Lyman [10, p. 14].

“On a personal level, as educators, caring practice claims on our attention can begin with the evidence that young persons who experience caring grow more substantial than those without caring characteristics. Fundamentally, they have a better chance of learning and becoming caring people”.

According to Roshelle [22], educators often focus on the content of the course that is going to be taught. However, it is more prudent to first acquire information about the nature of students' prior knowledge to know whether it is 'active, sufficient, appropriate, and accurate. Prior knowledge as mentioned earlier could either help or hinder learning [18]. Prior knowledge that is 'inactive, insufficient, and inaccurate' could hinder the learning of a student. Subsequently, one of the characteristics of prior knowledge that hinders learning is that it is inaccurate. Consequently, inaccurate knowledge could lead to misconceptions [15].

1.1 Aim of this Study

To assess the students' prior knowledge of Biology subject content as a pathway to student success.

1.2 Research Questions

- What challenges and concerns did the students have with respect to the inadequate understanding of Biology subject content?
- How effective is the assessment of students' prior knowledge in the early identification of at-risk students?
- What Intervention strategies and techniques might be employed to enhance their understanding and students' performance?

2 Theoretical Framework

Theories of teaching and learning have been developed from time immemorial, and almost all of them narrate presumptions that learning occurs when a trained teacher mediates it in a school classroom setup [11]. This study is based on the theory of care. From the educational perspective, the care philosophy orientates teachers/educators/lecturers toward teaching students to care for themselves and one another; and recognising the demands of caring for students to meet their academic and social needs [12]. This theory was applied in nursing, wherein care is the essence of nursing, and culturally based care guides nursing decisions and actions. The major components and assumptions of the care theory articulate caritive factors, transpersonal caring relationship between the student and lecturer or patient and doctor in an occasion caring. Moreover, transcultural nursing is a humanistic and scientific care discipline. There can be no curing without caring and healing but caring can exist without curing. It is essential for well-being, health, growth, and survival.

As Noddings [12] attested, care ethics should embrace engrossment and explains engrossment as receptive attention. Furthermore, Noddings [12] alluded that in a caring relationship, the carer is the first to draw attention to the needs of the cared-for, and this attention is receptive. All of these imply that the carer puts his/her values and projects aside and tries to entertain and understand the needs of the cared-for. Moreover, this theory extends to the notion that the key to understanding how the carer can become effective then there is a need to assess the student's prior knowledge and background in relation to the learning experience to ensure an effective interaction through the academic journey. The relationship between students and lecturers becomes the assumptions and beliefs that are taken into cognizance in the teaching and learning centre.

3 Literature Review

3.1 Understanding the Concept of Students' Prior Knowledge

The concept of prior knowledge has its roots in different learning theories, principles, and philosophies. As students vary in the background where they come from and along their journey from place to place to the classroom, they imbibed a broad range of pre-existing knowledge, beliefs, skills, and attitudes which could affect how they receive, understand, and organize new knowledge [20]. Moreover, these broad pre-existing are prior pieces of knowledge of the learners. Prior knowledge may help or hinder the student in learning, depending on the nature of prior knowledge.

According to Rochelle [22], educators often focus on the content of the course that is going to be taught. However, it is more prudent to first acquire information about the nature of students' prior knowledge to know whether it is 'active, sufficient, appropriate, and accurate. Prior knowledge as mentioned earlier could either help or hinder learning [18]. Prior knowledge that is 'inactive, insufficient, and inaccurate' could hinder the learning of a student. Subsequently, one of the characteristics of prior knowledge that hinders learning is that it is inaccurate. Consequently, inaccurate knowledge could lead to misconceptions [15].

This is the reason the nature of prior knowledge should be assessed before the commencement of any learning process. Noteworthy, prior knowledge that is inaccurate in nature may distort the learners' perception of the current information to be grasped. Although it is difficult, teachers should be able to diagnose and correct learners' misconceptions beforehand. This study builds on and contributes to work in understanding students' prior knowledge as a pathway to student academic success. This is a pivotal area to study because the alienation of students in higher education should be mitigated and decontextualized classrooms should either be dispelled for effective engagement. Students come to every learning situation with prior knowledge, skills, beliefs, and concepts that significantly influence what they notice about the situation, and how they organize and interpret it. This affects their ability to remember, reason, solve problems, and acquire new knowledge [7].

3.2 Four Common Concerns and Challenges Pertaining to Prior Knowledge

Generally, prior knowledge facilitates new learning. However, four common prior knowledge conditions can impede learning [17, 19]:

Insufficient Prior Knowledge

When students lack relevant background knowledge, learning is likely to be fragmented and incomplete. Students will struggle to identify the meanings of new terminology, differentiate main ideas from detail, grasp how one idea relates to another, and build a coherent representation of the lecture material. According to survey results, more than half of first-year report that they come to class unprepared sometimes, and an additional 19% report being unprepared often or very often [7].

Inaccurate Prior Knowledge

Student misconceptions of the subject matter are common and can interfere with new learning. Some misconceptions are minor glitches that students work out on their own; others can be tenacious, resistant to instruction, and lead to serious misinterpretations of new material [22].

Inappropriate Prior Knowledge

Students may use inappropriate or irrelevant prior knowledge to interpret lecture material. For example, the terms, average, confidence, and random have vastly different technical meanings in statistics than in common colloquial usage. Students who have colloquial definitions in mind will be confused by a statistics lecture on these topics [10].

Inert Prior Knowledge

Students may possess relevant prior knowledge but may not access it or be able to use it when needed. Students' inability to transfer recently acquired concepts to new contexts can be a significant obstacle to learning [17]. This necessitates fast learning and ensures proper application of the content in their ongoing lessons.

Although several studies in the literature have examined the students' prior knowledge as an enablement for student success, however, there has not been any study that extensively proposed strategies and techniques to apply when there are decontextualized students. As such, this report provides additional insight into this growing and competitive area of interest in the research community.

4 Methodology

4.1 Research Approach

The findings of this paper arose from Mixed Methods Research (MMR). Mixed Method Research was recognised around 2000 [13] and is referred to as a method that involves both quantitative and qualitative approaches [14]. Six MMR designs are commonly used in educational research [15]. Those varieties include, a) Parallel usage of qualitative and quantitative approaches to concurrently collect and merge data; b) Employment of consecutive explanatory approach (1), which entails first gathering quantitative data and then qualitative data to enhance the quantitative findings; c) Explanatory consecutive approach (2), which requires the first exploration of qualitative data followed by the collection of quantitative data that supports the qualitative; d) Embedded approach, which involves the collection of quantitative and qualitative data at the same time where findings of the two support each other; e) transformative approach which brings to light a possible change in perspective through the engagement of either the convergent, explanatory 1 and 2 or embedded designs within an evolving context. In this study, the researchers were able to obtain numerical and descriptive data to comprehend the difficulty index of the content and posit effective intervention strategies with the aid of statistical analysis of the report.

4.2 Data Collection

Phase 1

Data were gathered by employing the explanatory sequential approach (2) [15] in the first semester of 2022 (Fig. 1). Prior to the commencement of the academic lectures, the module facilitator assessed students' prior knowledge through the questionnaire-based study uploaded on the Moodle platform. The qualitative approach was employed using semi-structured questionnaires (Fig. 2). The purpose of the study was thoroughly explained to students, and they were requested to participate voluntarily by signing the consent section of the questionnaire. Generally, students were advised to mention biology subject-related content covered at their matric, and the most challenging aspect was indicated. Ethical approval was sought from the students prior to their participation in this study.

Phase 2

The components of the module content obtained from the student's questionnaire in phase 1 were further assessed to single out the difficulty index of all key aspects and concepts using the Relative Frequency of Citation (RFC) adopted from [16]. The relative Frequency of Citation is determined by the formula:

$$\text{RFC} = (\text{FC}/\text{N}) \times 100,$$

wherein FC is the times and aspect mentioned, and N is the total number of participants.

The module instructor delivered a standard lecture on the identified challenging aspect and the pedagogical approach was employed with student-centered learning,

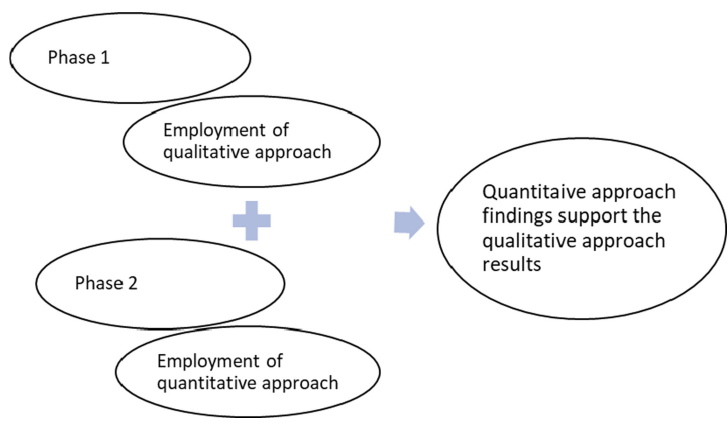


Fig. 1. Explanatory sequential data collection approach [15]



Assessment of first year students’ prior knowledge as a pathway to address inadequate mastery of academic literacy.

Iconsent to participate in the abovementioned investigation and declare that I will provide the information which is the true reflection of my knowledge.

Gender	
Age	
Home Language	
Matriculation year	
Type of school attended (Please tick from the three options provided in the next column)	Urban-based public school Rural-based public school Private school
Matric pass level in life Sciences	
Did your School have laboratory facilities	
Aspects of Life Sciences covered in Matric syllabus	
Difficult aspects encountered in Life Sciences during matric	
Any other comments about strategies to deal with challenging aspects of Life Sciences	

Fig. 2. Semi-structured questionnaire used in this study.

students' understanding was assessed, and marks were recorded. In the next step, the instructor explored different learning styles to foster students' understanding. The distinctive styles utilised include collaborative learning using talents such as drama, singing, poetry, and talk shows to highlight their understanding of the subject matter. In addition to their talents, students mimicked the process involved in the aspect through biological models.

Likert scoring was used to evaluate the importance of the intervention employed by asking the following questions: a) is there any noticeable improvement after the intervention; b) did you collaborate effectively with other group members; c) did all members participate fairly? Finally, test 2 on the same subject matter was administered, and the marks were recorded. Correlation analysis was utilised to explore the interrelations between the type of schools attended, Life Sciences matric pass levels, availability of laboratories, and Life Sciences matric pass levels.

5 Results

A total of 186 students participated in this study and the majority of the (113) students enrolled in the Foundation Biology Module were Tshivenda-speakers. Sixty-four percent of participants were females, and 92% of the entire cohort, were aged between 17 and 20. Moreover, participants attained matric pass endorsement from rural-based schools (145), urban-based schools (32), and only nine from private schools.

Subsequently, only 27% of all types of schools mentioned had laboratories for practical purposes. Sixty-eight percent of the students enrolled for the Foundation Biology module matriculated during the academic 2021. Only 16 participants passed Life Sciences with level 6, whereas the majority (98) passed with level 4, followed by 72 passed with level 5 (Table 1). Analysis of the correlation between the type of schools attended by students and Life Sciences matric pass levels was strongly positive. Furthermore, the strongest positive correlation was illustrated with respect to the notion of students' access to laboratories in secondary schools and Life Sciences matric pass levels (Table 2).

It is imperative to elucidate Genetics had a 52.7% relative citation frequency as a challenging subject among the elements that the students did not understand at their matric level. This element of the content was followed by evolution with 39.7% relative citation frequency (Fig. 3). These analyses necessitated an early detection of at-risk students and initiative-taking interventions to ease the difficulties in understanding the concepts of Genetics.

Generally, the at-risk students performed well in the post-intervention task with a high score of 98% as compared to a high score of 86% obtained from the pre-intervention (Fig. 4).

The Likert scaling revealed 82% improvements in students' understanding, whereas 71% attested fair participation in the mini projects conducted to impart an enhanced understanding of the subject matter (Fig. 5).

Table 1. Sociodemographic characteristics of participants (N = 186)

Sample characteristic	N	%
Gender		
Females	103	55
Males	83	45
Age		
17–20	176	94
21–23	9	5
24–26	1	1
Home Languages		
English	1	0.5
Afrikaans	0	0
IsiNdebele	1	0.5
IsiZulu	4	2
IsiXhosa	0	0
IsiSwati	3	1.5
Tshivenda	113	61
Xitsonga	27	15
Sepedi	36	19
Sesotho	0	0
Setswana	1	0.5
Type of schools attended		
Urban-based public schools	32	17
Rural-based public schools	145	78
Private schools	9	5
Availability of laboratories at schools		
Yes	32	17
No	154	83
Year of matriculation		
2015	1	0.5
2018	2	1
2019	3	1.6
2020	36	19
2021	144	77

(continued)

Table 1. (continued)

Sample characteristic	N	%
Life Science Matric Pass levels		
1	0	0
2	0	0
3	6	3
4	98	53
5	72	39
6	10	5
7	0	0

Table 2. Correlations between the type of school attended by students, Laboratories availability, and Life Sciences matric pass levels (N = 186).

	Type of School Attended	Lab availability	LS Matric PL
Type of School Attended	1		
Lab availability	0.362	1	
LS Matric PL	0.48	0.43	1

Lab = Laboratory LS = Life Sciences PL = Pass Levels

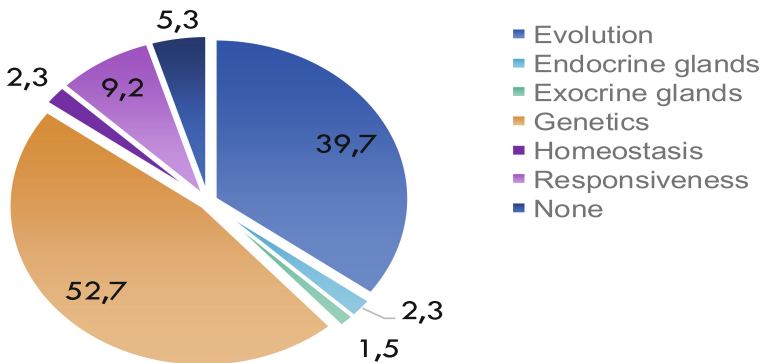


Fig. 3. Relative Frequency of citation of challenging biological subject content.

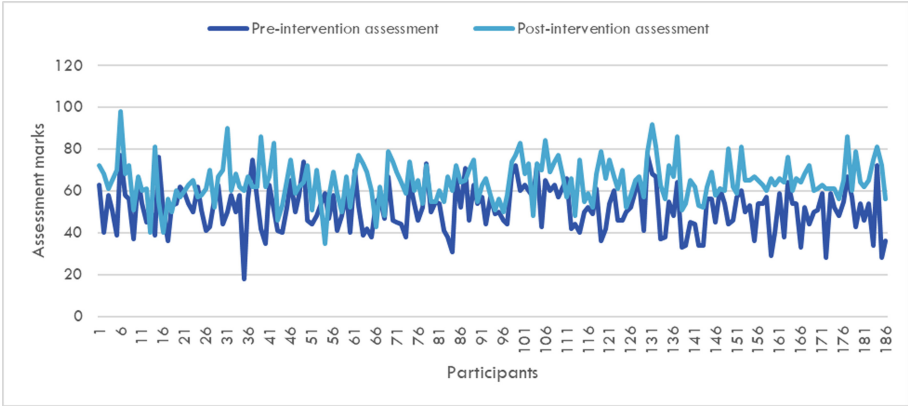


Fig. 4. Pre- and Post-intervention assessment results.

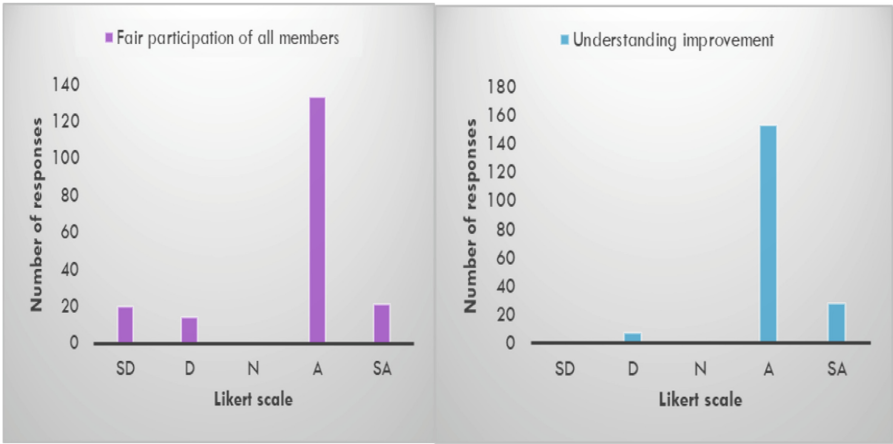


Fig. 5. Likert scaling of students' participation and understanding improvements.

6 Discussion

This study aimed to assess students' prior knowledge as a pathway to ensuring academic performance improvements. The findings that emerged from this study accounted for the significance of students' prior knowledge considerations to successful academic achievements.

Understanding Students' Backgrounds as a Tool to Identify Their Needs

The student's performance in the formative assessments illuminated positive contributions of prior knowledge towards early identification of at-risk students' learning engagements and performance [17]. Subsequently, this enabled the module instructor to contemplate the possible interventive measures toward the students' challenges

and difficulties in the module content. Thus, the alienation of the students from previously disadvantaged school backgrounds was minimised through the assessment of prior knowledge among the diverse student population. The results of this activity, therefore, posit a complete recalculation and transformation of the curriculum to ease the difficulty of the module content reported with the high relative frequency of citation. This is in line with care theory wherein the career is making every possible effort to understand and gratify the students' needs. Significantly, this theory aided a module instructor to have effective engagement.

Assessment of Students' Prior Knowledge as a Pathway to Academic Success

The consideration of students' prior knowledge moderately contributed to restructuring teaching and learning styles, such as applying students' talents to their academic achievements. Nevertheless, lecturers have a clearer understanding of the student's prior knowledge levels, which assisted in relooking their teaching strategies to meet the student's needs. Fundamentally, students' prior knowledge affords a good baseline for improving teaching and learning. This is in contrast with the findings of studies conducted by [17] on the notion that there is a need for reflection in relation to improving instructor's teaching and student's learning, the current researchers are of the perception that student's background necessitates an effective interaction in line with Care theory on gratifying the needs of others, students in particular.

Relative Frequency of Citation of Challenging Biological Subject Content

The analyses of the graphical presentation of the most challenging aspects for students from their grade 12 Life sciences content and the topics illustrated in the pie chart encompass evolution, endocrine glands, exocrine glands, genetics, homeostasis, responsiveness, and the students seemed not to comprehend these topics in the secondary grades. These analyses aided to identify the difficulty index and early detection of at-risk students and further assisted the lecturer to allot reasonable time and pay meticulous attention to the challenging topics. Moreover, the students tend to direct the teaching and active participants in the lessons. The students mentioned genetics and evolution respectively, when the lecturer commenced with the lectures, the prior knowledge, and new knowledge are integrated into the lectures from the known to the unknown subject content.

Student-Centered Engagement Through Collaborative Work

Lectures in higher education sectors can have many prospects to engage with students. Most significantly, if the engagement is of high quality, the ultimate results influence the inspiration of students' participation in the module activities [18]. Furthermore, previous research concurs with this paper that caring relations between the lecturer and students tend to influence the degree to which students participate in class activities [19]. The researchers explored the diverse learning styles and cooperative learning and peer-to-peer interaction on the most problematic units of the module content. The findings are congruent with the previous study conducted by Dochy [17] who articulated that the learning styles should be engaged in line with the constructivist approach to how students bring their pre-existing knowledge in order to ensure the accurate and appropriate

acquisition of knowledge. This enables the module instructor to group students for they to learn from each other and address misconceptions.

Effectiveness of the Intervention Strategies on Student Performance

The feedback from students' performance of the pre-and post-intervention tasks evidenced that students benefited from the pre-intervention task through the realisation of the misconception and inadequate understanding of certain sections of the module content and paying meticulous attention to that for better achievements on the assessment tasks. Furthermore, the pre-intervention assessment tasks assisted students to realise and understand that their knowledge investment is required to prepare for the upcoming assessment tasks [20]. This study established that explicit emphasis on collaborative activities aided students to build fair participation that enabled improvements in their performances [21]. In addition to fair collaboration, another type of necessary knowledge that positively or negatively affects students' learning is their epistemological perspectives. Hogan [21] reported similar observations in his study on a test of an intervention to foster students' collaborative scientific reasoning.

7 Conclusion

This study aimed to assess students' prior knowledge as a pathway to ensuring academic performance improvements. The findings that emerged from this study accounted for the significance of students' prior knowledge considerations to successful academic achievements. This is an important study, and it adds tremendously to the literature by proposing intervention strategies and techniques such as those that have not previously been employed in the literature. Fundamentally, the findings of this study deduce the critical role of prior knowledge assessment in students' academic performance. However, its implementation at the beginning of the course or module may be an essential tool to identify aspects of the module content that need more exploration, hence, developing new, improved teaching and learning strategies to meet students' needs.

Assessing students' prior knowledge allows lecturers to customize their teaching to meet the student's needs. Consequently, these simple and adaptable strategies may help lecturers gain an understanding of what their students do and do not know in short order in line with care theory, which would be a good relationship between students and lecturer through a consultation session. The lecturer tends to be directed by the student's needs, not the syllabus and curriculum content that might be irrelevant and outdated due to societal trends. The student-centered pedagogical approach becomes the focal point, and the outcome of this strategy is quite noticeable as it enables and expedites the early identification of at-risk students and pays meticulous attention to such a group through regular meetings.

Consequently, prior knowledge assessment can be executed for various purposes, including identifying innovative and creative ways to tackle the difficulties in the module content and grouping students according to their previous exposure to encourage diversified ideologies. Noteworthy, it is vital to concede that distinct types of prior knowledge have different relevance to students learning engagements and achievements.

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