Investigating Student Achievement Using Equitable Assessments and VARK: An Experimental Study of Secondary School Students in Pakistan

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Abstract

Students have diverse learning needs and unique learning styles. Providing options in assessments to address those needs helps eliminate rote learning and also addresses learner diversity (Pauline & Collings,2018). This study aims to promote student learning by designing teaching activities and assessments to support all students. This experimental study addressed learners having different learning styles and investigated the impact of equitable assessment practice grounded on universal design for learning on the academic achievement of 64 9th graders in a Physics course at a Secondary School in Pakistan. The relationship of VARK learning style on academic achievement was also investigated. The results indicated a significant difference (p = 0.00 < 0.05; Mean difference = 4.031) between the academic achievement of the control and the experimental group supporting equitable assessments and the UDL approach. The correlation between the learning style and academic achievement was not significant. The outcomes of the study recommend that consideration of learning style and needs of students while designing the learning and assessment content can bring better learning outcomes. The results also showed that there is a moderately positive correlation between bimodal learning style and a moderately negative correlation between auditory learning style with the academic achievement of students. It is recommended that the learning style and individual needs of the students should be addressed during the learning and assessment phase.

Keywords Assessment to promote learning, learning style, student diversity, academic achievement, equitable assessments.

Introduction

Every learner is unique and has diverse learning needs. The unique traits, beliefs, characteristics, and values present in an individual are referred to as diversity. Diversity also includes students with diverse learning styles (DeVore et al., 2008). Many factors influence it, which include learning profiles, learning preferences, gender, socioeconomic status, age, language, culture, and learning style (Bozkurt & Izci, 2020; Horzum & Izci, 2018). A one-size-fits-all method of teaching and assessment does not fulfil the needs of all students in a classroom. To address the needs of diversified learners in a classroom, it is important for teachers and administrators to be well-informed about the different diverse groups of learners in the class, how these differences influence individuals' learning processes, and how to provide equitable assessment practices to cater to the needs of diverse learners.

To support learner diversity in the classroom, learning style is one of the ways that can be used to identify a learner's personality and use it as a tool to differentiate and incorporate learning needs and preferences in the learning procedure (Francis, 2016). The VARK model developed by Fleming (2001) is widely used to identify students' learning modality & diversity as it provides a means to identify a learning style and suggests teaching approaches associated with the Universal Design for Learning (UDL) classifications.

Numerous research has been carried out about the impact of learning style on student achievement, and there are varied views on it. For example, Becker et al. (2007); Csapo and Hayen (2006); Ishak and Awang (2017) have a notion that learning styles have a strong relationship with achievement. In a study conducted by Martinez and Tuesca (2019) in a medical school at Columbia, it was concluded that there was no association between the VARK preferences and the achievement scores. In another study, conducted by Moayyeri (2015) it was concluded that students with reading learning styles had the highest achievement score, while the students having visual preferences had the lowest scores. Similarly, Francis (2016) conducted a study among B. Ed students concluded that apart from curriculum and instruction, teachers should employ a variety of assessment techniques focusing on the learning style for the whole brain development of students. The research of Florian and Spratt (2013) showed that learners with diverse needs are offered multiple pathways in their learning while the assessment approaches that take learners' needs and tastes into consideration and focus on students' strengths can help improve the learning process.

This study investigated the impact of equitable assessments designed according to the UDL principles, on student achievement and the relationship between the learning style and student achievement in the context of secondary school students in Pakistan. The learners' preference was identified using the learning style instrument VARK, and assessments were designed using the

UDL approach in different formats. The impact of this methodology on the student learning outcome was investigated, along with the effect of the learning style on student achievement in a science classroom. The correlation between VARK and student achievement was also investigated.

Research Questions

The following research questions were addressed in this study.

1. Do equitable assessments result in higher student achievement for experimental group in science learning as compared with students in a control group?

2. What is the impact of learning style on student achievement?

3. What is the correlation between the learning style and student achievement?

Theoretical Foundation

Every child has unique strengths, and a one-size-fits-all approach does not meet the needs of every child. To adapt the curricula, pedagogy, assessments, and instructional methods to address students' needs, we need to identify how learners differ from each other. Learner diversity is displayed through features such as learning profiles, learning preferences, gender, socioeconomic status, age, language, culture, and learning style (Horzum & Izci, 2018). Learning style is a key factor in addressing learner diversity (Alkathiri et al.,2018; Martinez & Tuesca, 2019). This study implied learning style to identify different types of learners in the classroom and then address that diversity using Universal Design for Learning and equitable assessments in order to include all the learners in the learning and assessment process.

Learning Styles

A set of preferences, behaviors, and attitudes that facilitate student learning is called a learning style. Kolb, Felder–Silverman, Fleming, Honey and Mumford, Gregorc, Dunn, and Dunn developed the widely known learning style definitions and instruments. Kolb and Kolb (1984) defined learning style as a person's specific interest or way to receive information and to develop knowledge. Felder and Silverman (1988) defined learning style as the attitude and strength of students in receiving, organizing, and processing data. Gregorc (1984) stated that information is perceived in both concrete and abstract ways, irrespective of the perception pattern, i.e., sequential or random. Dunn and Dunn (1986) described learning style as to how an individual absorbs or retains information and stated that every individual has a different interest, the process of receiving information, transformation to knowledge, and area of focus. Fleming (2001) described learning style as a person's traits and preferred method of gathering, cognizing, organizing, and reflecting on the information gathered. Each learning style stated above can be categorized based on cognitive, sensory, environmental, and personality modalities.

VARK MODEL

The VARK model not only helps identify the learning style of students, but it also helps to find ways to improve learning (Prithishkumar & Michael, 2014). It includes factors that help improve student achievement. The VARK model was developed by Neil Fleming in 1987 to aid students to know about their learning. It is an abbreviation of Visual (V), Aural (A), Read or write (R) and Kinesthetic (K). It deals with sensory modalities which are strongly linked to the principles of UDL and is based on the work done by Bruner (1967) and Piaget (1990) about the cognitive development and thinking of children. A summary of each learning style as explained by Fleming is as follows.

The term "visual learners" refers to the learning style with a tendency of visualizing to retain information. Students with this style prefer pictures, maps, graphics, posters, diagrams, text, etc. and learn by observing and can be easily distracted by movements, but the noise does not burden them (Drago & Wagner, 2004; Murphy et al., 2004; Othman & Amiruddin, 2010).

Auditory learners prefer to learn by listening and speaking over reading and writing. These learners work well in group settings to discuss or collaborate vocally. They enjoy reading aloud to themselves and like to participate in debates and discussions or give oral presentations (Drago & Wagner, 2004; Miller, 2001).

Students who possess a reading and writing learning style obtain information by focusing more on text and words. These learners prefer textbooks, lecture notes, and worksheets and do not prefer group work. Students with this learning style like to arrange lecture notes into mind maps, lists, glossaries, paraphrases, and classroom notes (Drago & Wagner, 2004; Miller, 2001; Othman & Amiruddin, 2010).

Kinesthetic learners learn effectively by engaging all their senses during learning. They tend to prefer touching and hands-on activities. The students with this learning style emphasize experiential learning and prefer to touch and move while interacting with the environment, making models or doing physical and hands-on activities (Drago & Wagner, 2004; Murphy et al., 2004; Armstrong, 2004).

Universal Design for Learning

Universal design for learning (UDL) is a framework based on research that provides an equal window to all learners, and it proposes diversified teaching approaches developed by Rose and Meyer (2002) in the US.

UDL is classified based on three principles, including representation of content, action, expression, and engagement methods (Hitchcock et al., 2002; Rose & Meyer, 2002). It supports the need of diverse learners and provides opportunities in curricula and teaching methods that encompass

the how, what, and why of learning (King-Sears, 2009). The UDL framework helps eliminate the barriers to learning and supports learner variability through flexible assessments by aligning assessments to learning goals (CAST, 2018). Hence, UDL-designed assessments reduce barriers, and students share what they know. To promote access and participation of learners, the three primary principles based on neuroscience research are multiple means of representation, action and expression, and engagement.

The multiple means of representation provide learners with multiple ways of perceiving and acquiring information and affect what students learn. This principle reinforces the presentation of information and teaching content in multiple ways to support students' learning styles and students with different abilities. For example, some students learn more effectively through visual or auditory means than the text; similarly, students with a sensory or learning disability may approach the learning content differently. The learning content was designed using this principle to address the needs of different types of learners.

Multiple ways of action and expression provide options for learners to organize and demonstrate their learning according to their learning style or individual abilities. For example, some students express their abilities well in the text but not in presentation; similarly, students who have executive function disorders or language barriers may approach their learning task differently. This principle is implied in the Post-test designed to assess the impact of equitable assessments on student achievement and the effect of learning style on student achievement.

The third principle stimulates motivation and enthusiasm for learning in various ways that are relevant to learners' motivation and strengths. It helps stimulate students' interest in their neurology, culture, or background knowledge. For example, some learners get frightened when exposed to a new methodology of teaching or assessments, while others are engaged by spontaneity and novelty. Similarly, some students ought to work in groups while others like to work alone. By using this principle, the teacher can provide multiple options for learners to demonstrate their learning, who may face a barrier in expressing their learning on a standard test due to barriers in test, the barriers may be due to media, format, meaning, or paper and pencil alone (Finnegan et al.; Rose & Meyer, 2002).

Integrating multiple ways to express knowledge by making the flexible assessments line up with the UDL principle of action and expression. It is important to design assessments dynamically that provide personalization and adaptation for students (Rose & Meyer, 2006). There is limited research in this context, but student diversity should be addressed in teaching and assessment. This concept is hardly used in the education system of Pakistan, and student performance is evaluated using paper-pencil tests. Rapp and Arndt (2012) and Scott and Bruno (2018) stated that the

assessments should vary whether formal or informal, formative or summative, paper & pencil or portfolio. Moreover, aligning assessments and student performance to the learning objectives provides a full overview to the teachers about student performance along with supporting students to develop an understanding of their learning process (Fisher & Michael, 2018). The UDL framework helps eliminate the barriers to learning and supports learner variability through flexible assessments by aligning assessments to the learning goals (CAST, 2018). Hence, UDL-designed assessments reduce barriers, and students share what they know.

According to Prensky (2010), learners like to participate in discussions, and group work, explore ideas, share them and like to be acknowledged. These students are more motivated and engaged in learning; moreover, the varied assessment and teaching activities can help them improve their understanding of the topic by analyzing, evaluating, and creating the knowledge gained during the learning process. In a study conducted by Roseanna Boruke and Mandia Mantis in 2013, it was concluded that a range of teaching approaches benefits learners, and diverse assessment approaches better inform student learning. Murillo and Hidalgo (2017) also support the notion that aligning assessment with students' needs makes it equitable. Hence, assessment must be according to the learner's interest and use different types of tests and instruments.

Equitable Assessments

The use of assessment practices that provide equal opportunities for all learners to engage in learning and express their learning is known as equitable assessment (Bozkurt & Izci, 2020). In Pakistan, teaching at secondary schools revolves around board exams. Using the traditional learning process and ignoring modern assessment yields low-quality education (Christie & Khushk, 2004). The design and content of the exam papers rely on the memorization capacity of students and are weak in assessing their abilities (Khan, 2011). The previous research shows a strong positive association between assessments with student achievement (Black & Wiliam, 1998; Tomlinson & Imbeau, 2011; Kaur et al., 2019; McMillan, 2013). Hence, it is important to conduct classroom assessments effectively. In a review study conducted by Rasooli et al. (2019), it was indicated that most of the studies used the term equitable assessment to provide equal opportunity to all learners regardless of individual differences. According to Siegel (2014) and Suskie, (2000), equitable assessment contains tasks that allow students to demonstrate their learning equally and get personalized feedback which improves student learning. Lyon (2017) and Siegel (2014) also emphasize that to support and assess student learning, teachers need to use equitable and varied assessment techniques. The assessments in Pakistan are also inflexible and do not give all learners an equal opportunity to demonstrate their learning (Nawani & Goswami, 2020). Hence, diversified assessment methods should be used that serve all the learners' needs, and they can express their

learning in their preferred method (Barrance, 2019). Hence, it is important to design assessments dynamically that provide personalization and adaptation for students (Rose & Meyer, 2006).

To design equitable assessments having different formats and allowing all learners to demonstrate their learning, the use of rubrics is suitable (Lee & Lee, 2009; Malouff, 2008). According to Andrade et al. (2008); Lee and Lee (2009), the use of rubrics enables teachers to evaluate diverse learners using multiple formats while keeping up the learning outcomes and standards given in curricula. The same rubric is used for evaluation, regardless of the activity or format of the question. So, whether the student expresses his learning in an oral presentation, writes an essay, performs an activity, or builds a model, the same rubric can be used (Katz et al., 2019).

Methodology

Research design

This study used a post-test quantitative quasi-experimental research design to determine the impact of learning style and equitable assessment approach on the achievement of students in science learning.

Sample and sampling technique

The target population included 9th grade students at semi-government schools in an urban city of Pakistan. The targeted city was Haripur Pakistan, which has three semi-government schools with approximately 500 students each in total. Non-Random Convenience sampling was employed to draw the sample from the accessible population. There were two sections of 9th grade in the targeted school, resulting in 64 students aged 13–16 years, including 33 boys and 31 girls as shown in table (1). The intervention was designed for the subject of physics and the topic of Force and Newton's Law of Motion was chosen.

Table 1

Research Participants and Groups

Baseline characteristics	Control Group		Experimental Group		Full Sample	
	n	%	n	%	n	%
No of Participants	32	50%	32	50%	64	100%
Males	17	53%	16	50%	33	51.5%
Females	15	46.8%	16	50%	31	48.4%

Data collection

The data were collected over three weeks in a semi-government school in an urban city of Pakistan. The pre-intervention survey VARK consisting of 16 questions, each having four options, was administered to identify the learning style and preferences of each student in learning. The lesson plans were then developed according to the learning styles of students for the experimental group. The researcher prepared the post-test comprising of eight test items against three student learning outcomes. The student achievement data were collected via this test, to gather information about the student's performance from both the experimental and control groups after the intervention.

Ethical considerations

Consent of the school Principal was obtained before conducting the research, and informed consent of the participants was also ensured. The information about participants was kept confidential, and confidentiality was ensured by removing student names from their post-test and generating Student IDs for reporting data. As part of the key instructional process, it was decided to introduce the learning activities and assessment tasks to students comprehensively. It was anticipated that students, when presented with different options, would intuitively opt for the format they were most familiar with. To counter this, a full presentation about the task was given, briefing the different approaches and formats so that those formats might be made more accessible for them.

Instrumentation

The data collection included a VARK questionnaire and a post-test on the topic "Newton's Laws of Motion" in the subject of physics. To know about the student's learning styles, paper copies of the validated VARK questionnaire were used. The VARK questionnaire contains 16 questions to identify the learning styles according to the sensory preferences, which were characterized as V, A,R,K and bimodal. Each item contains four options, and the students were asked to mark the answer that best matches their preference to the situation given in the question. Then, based on the scoring sheet, the modality that received the highest score was marked as the student's learning style. Some students scored equally high on two elements; he or she was considered to have bimodal learning styles. According to (Fleming, 2001), the VARK instrument has a Cronbach's alpha value from 0.77 to 0.85, which is good for strong internal consistency. The reliability of the VARK questionnaire is also assessed and confirmed by E D Fitkov-Norris and A Yeghiazarian (2015) and Mehdipour et.al (2018).

To gather information about the student's achievement, a post-test was administered. It was designed by the researcher and had eight different test items to check students' achievement against three learning outcomes related to the topic of "Force" and "Newton's Laws of Motions". The test was scored using a rubric. The topic, type, difficulty, distribution of questions and scoring scheme were the same for both the experimented and controlled groups to ensure the instrument's reliability. The posttest used multiple means of action and expression and included different formats, i.e., written, oral, and activities, to cater to the needs of all types of learners. The validity of the post-test was established through face validity. The researcher went to the 2 subject specialists of the school for face validity of the post-test.

The reliability analysis procedure was carried out on the post-test consisting of 8 items and yielded a Cronbach's alpha value $\alpha = 0.686$, which is acceptable and near to good (Creswell, 2012; Wells & Wollack, 2003). The reliability statistics of the post-test items indicated that the alpha value would decrease if the test items were deleted; hence all the items were worthy of being kept except item 6, which increased the alpha value to $\alpha = 0.701$. Since item six corresponded to student learning outcome three, the researchers chose not to delete the item.

Table 2

Reliability of Data Collection Tools

Data collection tool	Cronbach's Alpha Based on Standardized Items	Number of Items
Equitable Assessment	.668	8
VARK	0.77 to 0.85	16

Data analysis:

The Statistics Package of Social Sciences (SPSS 26) was used for the analysis of quantitative data. An independent sample *t*-test was used to measure differences in student achievement based on group, while differences in student achievement based on use of VARK were measured using ANOVA. To see the relationship of learning styles with academic achievement, a Pearson correlation test was conducted.

Results

Research Question 1

According to the descriptive statistics, a mean difference of 0.43 in achievement between the experimental and control groups was observed. It shows that the performance of the experimental group was better than the control group. As given in table (3), the Shapiro Wilk test yielded a *p*-value of 0.217 and 0.194 for the post-test of the experimental group and control group respectively, which is greater than 0.05. It shows that the sample data was normally distributed.

Table 3

Normality Test

	Group	Shapiro-Wilk		
		Statistic	df	Sig
Score	Experimental	.956	32	.217
	Control	.955	32	.194

Independent Samples Test

To compare the post-test results of control and experimental groups, an independent samples *t*-test was used. The 32 participants of the experimental group who were taught using the UDL method demonstrated significantly better achievement scores (*M* = 22.66, *SD* = 3.327)compared to the 32 participants in the control group (*M* = 18.63, *SD* = 3.108). Levene's Test for Equality of Variances as given in Table 4 shows that the significance value was 0.789 which is greater than 0.05. The *t*-test for equality of Means shows that p- value is 0.00 which is less than <0.05 so there is a significant difference between the means of the two groups.

Table 4

T-Test

		Levene's Test for Equality of Variances		t-Test for Equality of Means			
		F	Sig.	t	df	Sig.	Mean Difference
Score	Equal variances assumed	.072	.789	5.008	62	.000	4.031

The mean difference is 4.031, which reveals that the experimental group performed better than the control group. The difference in the mean value of the post-test scores for the experimental and the control group was significantly different (22.6 & 18.6), which shows that the achievement scores of the experimental group were higher than the control group.

Research question 2

The descriptive analysis showed that the mean achievement score of students with auditory modality was 18.58, the mean value of the students with reading/writing style was 19.63, the mean of the students having Kinesthetic style was 20.47, the mean of the students with visual style was 21.08, and the mean of students having bimodal style was 22.67. Students with bimodal learning styles scored highest, and the students with auditory modality had the lowest performance. Among the students who had bimodal learning styles, the students who had auditory + read-write learning style had a mean value of 24.50, and students with auditory + kinesthetic learning and visual + kinesthetic had a mean value of 21.80 and 21.40, respectively.

The ANOVA results as shown in Table (5) suggested there were no significant differences in students' achievement based on their learning style (F = 2.015, *p*-value = 0.078).

Table 5

One-way Analysis of Variance of Student's Learning Style and Academic Achievement

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	157.991	6	26.332	2.015	.078
Within Groups	744.744	57	13.066		
Total	902.734	63			

The statistical analysis of the results shows that there was no significant difference in achievement among students having different learning styles. The mean value of each learning style showed a slight difference from each other, although not significant. The students with auditory learning styles had the lowest achievement, and students with visual or bimodal learning styles had the highest achievement score.

Research question 3

The statistical analysis of correlation between learning style and student achievement implied that their correlation was not significant. As depicted in table (6) below, the auditory and bimodal learning style has a moderate relationship which is -.263 and .298 respectively. While the correlation (r) for all other learning styles (v=.057; R=.102; K=-.027) were very low positive and non-significant.

Table 6

Correlation of Learning Style and Student Achievement

Correlation of student achievement with	Correlation	
	R	
Visual Learning Style	.057	Very low positive non-significant relationship
Auditory Learning Style	-.263*	A Moderately negative significant relationship
Read write Learning Style	.102	low positive non-significant relationship
Kinesthetic Learning Style	-.027	Very low negative non-significant relationship
Bimodal Learning Style	.298*	A Moderately positive significant relationship

Discussion

The results fully support that teaching using UDL methods, considering students' learning styles, and providing options in the assessments can improve student achievement. The result as shown in table (4) indicates that considering the learning style of the learner and designing assessments and teaching content according to their preferred method of learning brings positive outcomes. The findings of this study are in line with the experimental research conducted by Spooner et al. (2007), in which the treatment group showed a significant improvement, supporting the one-hour UDL intervention effect. The results of this study concur with another study conducted locally by Javaid et al. (2020) which also revealed that UDL positively impacted student achievement. Similarly, the results of the review study by Oak et al. (2016) illustrated that UDL-

based interventions effectively address learner diversity for diverse students in secondary school students.

Although the learners' learning style helped in designing the content and assessments for this study, it has no direct impact on learning, as there are other factors involved as well. In a study conducted by Moayyeri (2015), about the relationship of learning style with student achievement, it was found that students having reading modality scored highest and the students with visual personality type had the lowest performance. Similarly, no notable difference in students' test results with different learning styles was found in the study conducted by Karakaya et al., (2001). Many researchers like (French et al., 2007; Marcy, 2001; Yeung et al., 2005) support the relationship between learning style and achievement and suggest that student learning styles should be kept in consideration while designing instruction and assessments. This indicates that using a combination of instructional approaches integrating multimedia helps neutralize the difference in students' learning styles. The results of the second research question were consistent with the research (Covaci, 2019), which concluded that the learning styles are independent of the outcomes, which implies that the students with different learning styles have similar learning gains. This indicates that using a combination of instructional approaches integrating multimedia and use of technology can help neutralize the difference in students' learning style (Lashari et al., 2022). The relationship between the learning style (visual, read/write and kinesthetic) and achievement was very low positive and non-significant, indicating that addressing the learning style can help neutralize the difference of learning style.

Conclusion

On the basis of the results, it can be concluded that it is crucial to know and understand the learning styles and needs of students in order to help them learn more effectively. Following the results of the student achievement for the experimental and the control group it was found that the experimental group performed significantly better than the control group. This indicates that considering the learning style of the learner and designing assessments and teaching content according to their preferred method of learning brings positive outcomes. Through this result, it was found that when teachers cater to the needs of the students and address each individual's learning style not only in the teaching process but also in the assessment phase, it helps increase students' learning outcomes. Since the students had more options rather than one method(paper/pencil) only, this flexibility allowed them to choose according to their learning style and express their knowledge. Hence, using equitable assessments and catering to the learning style in the assessment phase also helps improve students' learning. This is supported by the study of Ok et al., (2016) that UDL-based interventions effectively addressed learner diversity for diverse students in secondary

school. Hence, equitable assessments and UDL-aligned lessons significantly helped improve student achievement as compared to the controlled group. The findings of this study are consistent with the research carried out by Scott et al. (2014), in Alberta, Canada, about fair and equitable assessments. It is concluded that the assessment must be differentiated to accommodate the student's needs, background and learning style. It is also supported by the study conducted by Parveen and Awan (2019) that the education system of Pakistan needs to follow the principles of fairness and equity to improve quality of education. Assessment in teaching should also be student-centered, aligning with the student-centered teaching approach. Just as shoes bought from a store will not fit every foot, not every assessment tool will fit every student. Researchers need to support teachers by providing guiding rules, materials, and examples of equitable assessments to facilitate teachers' practices. Teachers should constantly strive to develop sensitive assessments to meet diverse students' needs.

The results also indicated that the learning styles are independent of the learning outcomes, hence, the learning style of student should be kept in consideration while designing assessments. The correlation coefficient of almost all learning styles did not depict a compelling relationship between learning style and student achievement. Only auditory and bimodal learning styles had a moderate relationship between the learning styles and academic achievement of students indicating that the learning style should be considered in the teaching as well as the assessment phase.

This study implied a posttest only design, future research can be conducted using the pre-post-test method. More samples could be generated, and it could be done in primary, secondary, and higher secondary levels in different subjects. To justify inclusive education, further research must be conducted to determine the impact on students with disabilities and explore the outcomes for all students. The application of UDL and learning styles using advanced technologies can also be investigated. It also demonstrated that the outcome advocates the needs of the participants of this study, and it cannot be generalized to the entire secondary school student population. Therefore, a more generalized outcome to apply this approach needs to be conducted in future.

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