SMART

Journal of Business Management Studies

(A Professional, Refereed, International and Indexed Journal)

Vol-12 Number-1 January - June 2016 Rs.400

ISSN 0973-1598 (Print) **ISSN 2321-2012 (Online)**

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Founder - Publisher and Chief Editor

SCIENTIFIC MANAGEMENT AND ADVANCED RESEARCH TRUST (SMART)

TIRUCHIRAPPALLI (INDIA)

www.smartjournalbms.org

SMART JOURNAL OF BUSINESS MANAGEMENT STUDIES
(A Professional, Refereed, International and Indexed Journal)
www.smartjournalbms.org

DOI : 10.5958/2321-2012.2016.00006.3

LEARNING STYLES AND ATTITUDES TOWARD THE USE OF WEARABLE TECHNOLOGY IN HIGHER EDUCATION: A STUDY AMONG INDIAN STUDENTS

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Abstract

Technological advancement in education sector has direct impact on the style and efficacy of delivery and utilization of educational content. Various novel communication and information technology-based tools and resources have enabled efficient, timely delivery of diverse academic concepts. Wearable Technology is one such technology, which has many potential applications. Wearable Technology-based gadgets are now influencing every dimension of human life. In the case of higher education, the use of Wearable Technology remains largely experimental. The purpose of this research is twofold; firstly, to examine students' attitudes towards the use of the Wearable Technology and secondly, to determine if attitudes towards the use of Wearable Technology differ, based on learning style. The results of the study found significant effect of learning style on the use/adaptation of Wearable Technology in teaching and learning among Indian post graduate students.

Key Words: *Wearable Technology, Learning Style, Attitude, Indian Students.*

JEL Codes: *C12, M15, C33*

1. Introduction

The advancement of technology has changed the way we think, learn and take decisions. With the advent of Internet, the concept of technology, used in our daily life, has changed dramatically. We have moved from the age of "fixed computing" to the age of "Internet of Things". Now we are moving from "Internet of Things" to "Internet of Everything". This transition has induced a new term called Wearable Technology. The term "Wearable" represents an evolution in our relationship with computing and hints at a future of ubiquitous connectivity, where the furnishings of our everyday life will be imbued with sensors, processors and information displays.

Wearable Technology is a small advanced electronic gadget, embedded naturally in clothing, accessories, or portable lightweight containers. Wearable technologies gather data from the body of the wearer or from the environment and provide information to the wearer. The word "wearable technology" is not a new terminology and it was around long before Benjamin Franklin invented bifocals. There is no formal definition of the term, but the following definition of "Wearable Technology" captures the essence of how the term is commonly used today (**On-line Museum and Encyclopedia of Vision Aids (2014)** :

"These are products that must be worn on the user's body, for an extended period of time, significantly enhancing the user's experience as a result of the product being worn. Furthermore, it must contain advanced circuitry, wireless connectivity and at least a minimal level of independent processing capability"

Wearable Technology offers a useful and friendly environment, for combining different user required functionality, in novel ways. The delivery of different useful services, using configuration of hands-free technology, will reshape the way work is done now. Integrating powerful stand alone wearable technologies, in different dimensions of human life, can improve user efficiency, productivity and usability of product and services. Wearable technology delivers relevant, context-sensitive information, to help users make better task-oriented decisions in the real world. It also creates a synergy that enables users to remain focused on the task at hand while automatically accessing relevant and useful enterprise resources. With the rise of Internet, anywhere mobile device use, user friendly interactivity interfaces and a recent push to make devices available for the ordinary consumer, make wearable technology more affordable and usable.

1.1 Wearable Technology in Education

Wearable Technology is the latest advance in education sector. This technology has redefined the concept of connected education. Inconspicuous wearable devices would be the landscape of educational computing. Wearable cameras, for instance, allow a learner to engage simultaneously as observer, reporter and participant. As the things the students/teachers own, have sensors to connect environment and process data, it opens new opportunities for the student/teacher to think differently, hear differently, and apply things differently. It also enables a new self-awareness and an enhanced perception of the world among students. Inconspicuous wearable devices like Google glass, watches, and cameras can change the landscape of learning and teaching pedagogy. It also provides a subjective point of view for digital story-telling. The data-gathering potential of these devices could support research by providing information collected without human interaction. In turn, new mechanisms for informed consent and re-examination of ethical practices, regarding use of personal data, should evolve.

With the invention of Google Glass, the methodologies of teaching and learning have dramatically changed. A student walks into the class and he is automatically presented with an outline of what will be covered in the lesson and homework instructions etc. For example, a student arrives at the physics lab and he is presented with step-by-step lab instructions that can be accessed hands-free, along with pictorial cues and labels. On the other hand, an instructor/teacher is able to associate information, such as names and grades, with student faces. These devices might offer powerful assistance to those with visual, auditory, or physical disabilities. Experts/teachers can monitor students remotely and recommend interventions. It can also help students struggling with language issues by immediate translation of the contents. In a distance learning setup, an instructor records hands-on demonstrations for students and connects with students remotely via Google+ Hangout. Students can hear the instructor speak, see and hear what the instructor sees in real time and have a discussion while the instructor is fully immersed in different activities. This new technology-enabled environment would affect the teaching and learning style of teachers and students.

1.2 Learning Styles

Learning Styles are the ways of perceiving and conceptualiz ing the relevant facts and figures. Learning style also influences the problem-solving capability of the learner. It is also a preferred way of interacting with and responding to the environment (**Francis, 2000**). According to **Cano, Garton & Raven, 1992),** learning styles is defined as the process that the learners use to gather and process information. Each individual has the basic capability to learn but it differs from person to person (**Gregorc, 1979**). **Garger and Guild (1984)** described the learning style as the individual characteristics which are stable and pervasive. It is expressed through the interaction of one's behavior and personality when he/she approaches a learning task. In 1984, **Kolb (1984)** provides a systematic statement of the theory of experiential learning. In 2005, **Kolb and Kolb (2005)** developed Learning Style Inventory (LSI) to fulfill the following purpose:

- ❖ To serve as an educational tool to increase the individual understanding of the process of learning from experience and their approach.
- ❖ To provide a research tool for investigating experiential learning theory and the characteristics of individual learning styles.

LSI Model is a four-step process that includes Concrete Experience (CE), Reflective Observations (RO), Abstract Conceptualization (AC) and Active Experimentation (AE). CE is the feeling component of taking information and then reflect on the experience. Using RO, the learner is able to see a concrete experience from other perspectives. In AC, the learner generalizes his/her observations into sound theories. Finally, in AE, the learner takes these theories and tests what they have learned in new ways. **Kolb and Kolb (2005)** mapped these four processes into a two dimensional plane by creating CE/AC and AE/RO dimension. CE/AC and AE/RO dimensions are opposite to each other.

The paper was organized into nine sections. Section 2 defines the problem statements for this study. The past researches related to wearable technology and learning preferences and learning style are discussed in Section 3. The need of this study is discussed in Section 4, followed by objectives in Section 5. Section 6 discusses the methodology adopted for the research. Findings and discussions, about the results, are presented in Section 7. Conclusion, limitations and future scope for the study are discussed in Section 8 and 9.

2. Literature Review

With the rapid change in technology, it is necessary to understand how it influences the teaching and learning process in higher education in India. As technology is an ever-present component in higher education pedagogy, more empirical evidence is needed to demonstrate the connection between students' preferences for learning and the use of latest technology like wearable technology. But there are not enough studies to analyze the cause and effect of wearable technology in the learning style of students. Hence the literature review section focuses on important literature, involving students' attitudes toward technology and its relation with the learning style. There are several issues that may arise while applying technology in the classroom. These are (1) choices about which technology to use (**Bascelli,Johnson, Langhorst, & Stanley, 2002**), (2) how effective technologies can reinforce learning (**Grasha, 1996**), and (3) technology's role in shifting from an instruction paradigm, which is teacher focused, to a learning paradigm, which is student focused (**Van Dusen, 1997**). The main challenge of technology-enhanced learning is that teachers must allow content to drive technology and but be cautious not to let technology to drive the content. In other words, the goal is to use tools that are appropriate to the needs of the learners and their learning experience (**Gynn, 2001**). There should always be good reason for including technology in the learning environment. Gynn points out that technology can be the tool that connects student to knowledge, student to other students and student to the teacher. According to Gynn, it is also important to make student comfortable with current technology and tools. She also found that comfort with using technology, has no relationship with the learning style but it affects learning. Hence it is important to ensure that all students are comfortable with the technology, by accommodating diverse learning styles. Several studies were reviewed which elucidate the importance and/or implications of the usefulness of technology regarding learning styles.

Montgomery (1995) conducted a study at the University of Michigan, which addressed diverse learning styles through the use of multimedia. **Buerck, Malmstrom, and Peppers (2003)** of St. Louis University, conducted a study entitled "Learning Styles and Learning Environment." The study examined student success in an internet-based versus a lecture - based computer science course. The results of the study showed that students in the face-to-face learning environment were more likely to have assimilating learning style, whereas students in the online course were more likely to have the converging learning style. They also found that academic success of students did not differ significantly because of learning environment selection. In 1993, **Gunawardena and Boverie (1995)** adapted David Kolb's experimental learning theory and Learning Style Inventory, to study the interaction between adult learning style and computer-mediated classes. They found that learning styles did not affect how students interacted with media and methods of instruction but they did affect students' satisfaction. They found accommodating learners being the most satisfied and the diverging learners being the least satisfied with class discussions and group activities. **Sein and Robey (1991)** also used Kolb's LSI to study the interaction between learning style and usefulness of computer training methods. They concluded that converger participants, who combined active experimentation and abstract conceptualization, performed better than participants with other learning styles. All these studies provided information about different ways in which technology- enhanced learning takes place and its significance in increasing learning. The use of technology and technology-enhanced learning should be used in such a way as to engage students in the ways they learn.

3. Problem Statement

The application of Wearable Technology is very broad and expanding its reach day by day. The impact of this innovative technology is already being felt in diverse sectors from glamour and fashion to medical devices and business operations. The following are the few areas where Wearable Technology has already proved its usability (**News.com.au, 2013**) i.e machine vision, video display, object/image recognition, speech recognition, change augmented reality, enterprise computing etc. In spite of different types of technology, learning styles play a crucial role for better learning. **McCarthy (1987)** postulated four types of learners i.e Accommodators, Divergers, Convergers and Assimilators, based on their position on the two dimensions representation, based on Kolb's learning types.

Accommodators perceive concretely and process actively. They learn by trial and error and they are interested in self discovery. They are also enthusiastic about new things. They are adaptable and flexible. They are also risk takers.

Assimilators perceive abstractly, process reflectively and devise theories. They also seek continuity, love ideas, and they are detail-oriented. They exhibit intellectual competence in traditional settings.

Convergers perceive abstractly, process actively, and integrate theory and practice. They are pragmatic, dislike fuzzy ideas and value strategic thinking. They like to experiment and seek results.

Divergers perceive information concretely and process reflectively. They are imaginative and believe in their own experience. They are insight thinkers and have high interest in people and culture.

From the above discussion about wearable technologies and learning styles, the problem statement of this study can be stated as:

1. To understand different learning styles and their effect on student learning in higher education
2. To understand the attitude of students towards Wearable Technology in higher education institutions.
3. To understand the relationship between Wearable Technology and learning styles.

4. Need of the Study

The past literatures show significant relationship between attitude, learning styles and different technologies. But unfortunately, not enough studies have been conducted among students of higher education in India. The needs of this study are to find the interrelationship among attitude, learning styles and wearable technologies in Indian academic environment. Results of the study may contribute to the information available to educators about the use of technology in the classroom. Using appropriate technology-based, learning style will serve to produce more desirable learning outcomes. Teaching students, based on their preferred learning style and their preferred technology, can increase their achievement level (**Dunn, Deckinger, Withers, & Katzenstein, 1990**). Thus the use of technologies, that match students' preferred style of learning, may have a positive impact on educational outcomes.

5. Objectives of the Study

The objectives of this study are threefold:

1. To examine student attitudes toward the use of wearable technology in higher education courses.
2. To specify any differences in attitudes based on students' learning styles.
3. To establish the relationship between attitude and learning style.

6. Hypotheses of the Study

Based on the findings and discussions in past literatures and the above listed objectives, the following hypotheses were formulated for this study.

H1: There exists a significant relationship between wearable technology and learning style.

H2: Gender significantly affects the attitude towards the use of wearable technology.

H3: Stream of students significantly determines the use of wearable technology.

H4: Learning styles significantly predict attitude towards the use of wearable technology.

7. Methodology

7.1 Population and Sample Selection

A convenient survey method was employed to collect data regarding demographic profile, learning styles and attitude towards wearable technology of post graduate students of various universities and colleges in India. The target sample size of 500(N) was considered for this empirical investigation. Out of 500 questionnaires distributed through e-mails and social forum during January to May, 2014, only 252 questionnaires were returned. After the initial data screening, only 212 questionnaires were found suitable as useable after discarding missing, erroneous or incomplete data from further statistical analyses. The survey response rate was calculated at 42%, which conforms to the standards of social science research. **Table 1** shows the demographic description of the sample.

7.2 Tools Used for the Study

An on-line questionnaire was designed, having two scales (learning style and attitude towards wearable technology) plus few demographic questions. A modified version of attitude scale was used to assess the students' attitude towards the use of wearable gadgets for teaching and learning. The instrument contained ' 11' statements in the questionnaire. The five point Likert-type Scale was used to collect the response options, ranging from (1) Strongly Disagree to (5) Strongly Agree. A modified version of Learning Style Inventory (LSI) (adapted from **Kolb (1984)** and **McCarthy (1996)**) was also used to capture the learning styles. Nine questions were asked to rank four sentences corresponding to the four learning modes i.e Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC) and Active Experimentation (AE). The format of the LSI is a forced-choice format that ranks an individual's relative choice preferences among the four modes of the learning styles. This is in contrast to the widely used Likert scale which rates absolute preferences on independent dimensions. The forced-choice format of the LSI was dictated by the theory of experiential learning and supports the primary purpose of the instrument. Content and face validity for the questionnaire was established by a panel of two expert faculty members and four post graduate students. The scales were pilot-tested for reliability, with 35 students from engineering and non engineering background. Cronbach's alpha coefficients were .76 and .71 for learning style and attitude scales respectively. An analysis of data was performed, using frequencies, means, standard deviations, t-tests, Pearson correlations, and regressions. The alpha level was established *a priori* at the .05 level. Data were analyzed, using the Statistical Package for Social Science (SPSS-18) software tool.

7.3 Data Analysis

The exploratory factor analysis, with principal component analysis and orthogonal varimax procedure, was applied to the collected data in order to verify the construct validity of the factors in Indian condition.

7.3.1 Exploratory Factor Analysis

The first task of this analysis was to check the factor structures of the LSI constructs and confirm them with the original studies. Hence the exploratory factor analysis was conducted, using the collected data. It yielded five factors, as shown in **Table-2.** All the factor loadings in **Table-2** were at an acceptable level and there were no cross-loadings above 0.4.

Even though exploratory factor analysis provides a measure of convergent and discriminant validity of constructs, it does not test for possible error correlations among items.

Therefore, a measurement model, using confirmatory factor analysis for each first-order construct, was developed. Then a first-order correlated model, on these '5' factors, was run to identify significant correlations among items. The model fit indices are listed in **Table-3**.

The recommended values, for chi-square/degrees of freedom, should be between 1 and 5 (**Salisbury, W.D. et. al, 2002**). According to **Hair, J.F. et. al, 1998,** GFI > 0.85 and AGFI > 0.8 represent an acceptable fit. Recommended values for NFI and TLI are > 0.90 and for CFI > 0.90 (**Salisbury, W.D. et. al, 2002**). RMSEA values, less than 0.1 signify a good fit (**Hu, L.T. , 1995; Salisbury, W.D. et. al, 2002**). The values found **(Table-3)** for different model indices, satisfied the acceptable levels and results showed no significant correlation between the items. Therefore, it confirmed the convergent and discriminate validity among the factors. Under the second-order constructs the five factors were verified by calculating the ratio of the chi-square values of the first-order and second-order models (**Marsh, H.W, 1990**). It indicated the percentage of variance, explained by the second-order model compared to the first-order correlated model. The *t*-coefficient value in this case was found to be 0.94. According to Marsh (**Marsh, H.W, 1990**), the recommended value for this coefficient should be above 0.8. The second-order coefficients, in the measurement model, were found to be significant at the 0.05 level. This indicated the presence of the second-order constructs for the factors. In otherwords, the results of the tests found both LSI and attitude as second order construct. LSI comprised of four first-order sub-constructs (Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE).) whereas Attitude had only one sub- component.

After the factor analysis, the participants were classified into four learning styles as Diverging (CE/RO), Assimilating (AC/RO), Converging (AC/AE), Accommodating (CE/AE), by mapping them into a two-by-two matrix (**Kolb, 1984**). The number of participants who followed different learning styles, is displayed in **Table-4**.

The factor reliabilities (Cronbach's alpha), means and standard deviations are shown in **Table-4.** The Cronbach's alpha is used as reliability score of the scales. **Nunnally, J.C., 1978** recommended at least 0.70 alpha coefficients for social sciences to be acceptable. The internal reliabilities of all scales were found satisfactory for the collected data, as shown in **Table-4**.

The correlation between different constructs is shown in the **Table-5**. The results showed that there was no correlation greater than 0.7 between different learners. Hence it can be asserted that there was no problem in multicollinearity in the collected data. But there were strong correlations between different types of learner and attitude towards wearable technology in learning. Hence hypothesis **H1** is found to be true.

When **Table-6** is examined, it is seen that the divergent learner [$t(211)=3.56$, $p<.05$] and convergent learner [$t(211)=1.23$, $p<.05$] students differed according to gender towards the use of wearable technology in the class room. From the results, it is also evident that under the divergent learner category, female students [M=68.32] dominated male students [M=66.78] whereas under the convergent learner category, male students [M=73.21] dominated female students [M=72.11] towards the use of wearable technology in teaching and learning. Other learner styles did not differ significantly, according to their gender, towards the use of wearable technology. The results also revealed that there was no significant difference in the overall learning style, with respect to gender [t(211)=2.63, p>.05], towards the use of wearable technology. Hence hypothesis **H2** is rejected.

When **Table 7** is examined, it is seen that the attitudes [t(211)=2.78, p<.05] of students towards the use of wearable technology differed significantly, with respect to their stream in favor of engineering [engineering($\bar{X}$=3.64), non engineering(=3.34)]. Therefore, hypothesis **H3** is confirmed.

From **Table 8**, it is observed that the learning styles of PG students were an important variable in the prediction of the attitude levels towards the adoption of wearable technology [R=.61, R^2=.31, F=10.23, p<.05] and that the learning styles could explain 31 % of the variance regarding the attitude levels towards the use of wearable technology. The results also indicate that assimilator learners were inclined more towards the wearable technology, followed by divergers, accommodators and converge respectively. Hypothesis **H4** is found true.

8. Finding and Discussion

This study was conducted to determine (1) learning style preference among students of higher education (PG students) in India, and (2) whether a relationship existed between students' learning styles and their attitude toward the adoption of wearable technology. This study found that maximum number of students were inclined towards assimilating learning style. The result also revealed that in the category of divergent and convergent learners, there were significant differences, with respect to gender, in adopting wearable technology in learning and teaching. The other learner group did not show any difference, with respect to their gender, towards the use of wearable technology. Further, it is evident that over all, irrespective of learning styles, there was no difference of opinion with respect to gender towards the use of wearable technology. The study found that there was significant difference in attitude towards the use of wearable technology, with respect to their proficiency in technology (i.e. engineers/non-engineers). Students were very positive towards the convenience of wearable technology to control their pace of learning. In order to identify any differences among learning styles, with relation to the wearable technology, a regression analysis was conducted. The result found significant relationship between learning style and attitude towards the wearable technology. The result demonstrated that there was relationship between attitude toward the use of wearable technology and students' preferred learning style. The regression results also showed that not all types of learners equally preferred the wearable technology. Among the four groups, assimilator learners were keen on the use of wearable technology in learning.

9. Conclusion

The results of this research paper revealed that students' learning styles were statistically significant for using/adopting wearable technology for knowledge acquisition in higher studies. This conclusion is consistent with earlier findings on the importance of learning style on learning attitude (**Ching-Chun Shih, Julia Gamon, 2001; M. Peker & Þ. Mirasyedioðlu, 2008; Hüseyin Çalýþkan, Güneþ Kýlýnç, 2012**). For the instructor-based learning class (traditional), the learning style is irrelevant but for the wearable technology - based learning class, learning style is significantly important. The results showed that assimilators were inclined more towards wearable technology. This implies that those learners, who like to learn through thinking and watching as well as those who like thinking and doing, would learn better with the wearable technology.

10. Limitation of the Study

The findings of this study enhance our understanding of how learning style influences the use of wearable technology among Indian students but limitations need to be acknowledged. The results of this study should be interpreted with certain caution. The instrument (partly) used in the present study was done using a Likert Scale. It is likely that the underlying fixed alternative answer to each question might affect the validity of results. More caution is required in designing such questions.

11. Scope for Future Research

The above mentioned limitation can be addressed in future, by designing suitable questionnaires, to study and analyze the relationship between technology and learning styles. Again, there should be further studies on learning styles and wearable technology at all levels (UG and PG), using greater sample sizes, with different characteristics, to verify the results of this study.

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Table-1 : Demographic Information of sample

Attribute	Characteristics	n	(%)
Gender	Male student	115	54
	Female student	97	46
Stream	Engineering	122	57
	Non-Engineering	90	43

Source: Primary data

Table - 2 The Result of Factor Analysis

	Concrete Experience (CE)	Reflective Observation (RO)	Abstract Conceptualization (AC)	Active Experimentation (AE))	Attitude
1A	0.81				
2C	0.79				
3B	0.83				
4A	0.64				
8D	0.66				
9B	0.71				
1B		0.78			
2D		0.67			
3A		0.66			
6C		0.65			
8C		0.68			
9A		0.73			
2B			0.72		
3D			0.75		
4C			0.68		
6D			0.72		
8B			0.64		
9C			0.68		
2A				0.61	
3C				0.74	
6B				0.62	
7D				0.72	
8A				0.59	
9D				0.64	
A1					0.71
A2					0.69
A3					0.75
A4					0.71
A5					0.67
A6					0.65
A7					0.67

Source: Primary data.

Table - 3 Result of Goodness of Fit

Model Indices	Values
Chi-square/degrees of freedom	1.3
Goodness-of-fit index (GFI)	0.86
Adjusted goodness-of-fit index (AGFI)	0.82
Normed fit index (NFI)	0.96
Tucker–Lewis index (TLI)	0.91
Comparative fit index (CFI)	0.92
Root mean square error of approximation (RMSEA)	0.05

Source: Primary data.

Table - 4 Result of Descriptive Statistics

	N	Mean	Standard Deviation	Cronbach's alpha
Divergent Learners	26	67.55	0.72	0.73
Assimilator Learners	109	65.72	0.81	0.77
Convergent Learners	65	72.66	0.67	0.72
Accommodator Learners	22	68.27	0.78	0.68
Attitude	212	3.49	0.82	0.74

Source: Primary data.

Table - 5 Correlations between Learning Style and Attitude

	Divergent Learners	Assimilator Learners	Convergent Learners	Accommodator Learners	Attitude
Divergent Learners	1	0.42*	0.29	0.36	0.72*
Assimilator Learners		1	0.41	0.44	0.73*
Convergent Learners			1	0.38*	0.82*
Accommodator Learners				1	0.76*

Source: Primary data
Note: *. Correlation is significant at the 0.05 level (2-tailed).

Table - 6 T-test Results of Different Learners and their Attitude Levels towards the Wearable Technology according to Gender

Learning Style/Attitude	Gender	N	$\bar{X}$	df	t	p
Divergent Learners	Male student	115	66.78	211	3.56	**0.03**
	Female student	97	68.32			
Assimilator Learners	Male student	115	66.21	211	3.12	0.13
	Female student	97	65.23			
Convergent Learners	Male student	115	73.21	211	1.23	**0.04**
	Female student	97	72.11			
Accommodator Learners	Male student	115	67.98	211	2.29	0.08
	Female student	97	68.56			
Overall Learning Style	Male student	115	68.90	211	2.63	0.11
	Female student	97	68.20			

Source: Primary data.

Table - 7 T-test Results of Different Learners and their Attitude Levels towards the Wearable Technology according to Stream

Variables	Stream	N	$\bar{X}$	df	t	p
Attitude	Engineering	122	3.64	211	2.78	0.00
	Non-Engineering	90	3.34			

Source: Primary data.

Table - 8 Regression Analysis Results for the Prediction of the Attitude Levels towards the Use of Wearable Technology by their Learning Style Preferences

Learning Style	B	Std. Error	t	p
Divergent Learners	1.75	0.64	2.34	**0.03**
Assimilator Learners	1.89	0.54	4.42	**0.00**
Convergent Learners	0.89	0.59	1.13	**0.03**
Accommodator Learners	1.17	0.41	2.43	**0.04**
$R = 0.61$, $R^2 = 0.31$, $F = 10.23$, $p < 0.05$				

Source: Primary data.