# Patterns and Predictors of Digital Microlearning Tool Use in Biology: A Quantitative Study of Higher Secondary Students


## Abstract

The rapid expansion of digital microlearning toolssuch as short instructional videos, quizzes, animations, and flashcardshas transformed science learning at the higher secondary level. Despite the increasing availability of these tools, little empirical evidence exists on how frequently biology students use them and what factors predict their adoption. This quantitative study investigates the patterns and predictors of digital microlearning tool use among 120 higher secondary school students across government and private schools. Using a validated Likert-scale questionnaire, data were collected on frequency of use, perceived usefulness, digital self-efficacy, learning motivation, and availability of digital resources. Descriptive statistics, correlation analysis, and multiple regression were used for data analysis. Results indicate moderatetohigh use of microlearning tools, with videos and interactive quizzes being the most preferred formats. Perceived usefulness, digital self-efficacy, and availability of digital resources emerged as significant predictors of usage. Gender and school type showed no significant differences. The study highlights the importance of building digital competencies, integrating structured microlearning in biology pedagogy, and enhancing device accessibility.



**Keywords:** Digital Microlearning, Biology Education, Higher Secondary Students, Predictors of Use, Digital Self-Efficacy, Learning Motivation


## Introduction

Digital learning ecosystems have rapidly expanded over the last decade, and microlearning has become a widely adopted instructional approach at the school level. Microlearning, with its focus on small, structured learning units delivered through digital tools, is especially useful in content-heavy subjects like Biology. The short videos, flashcards, interactive modules, and gamified quizzes offered by microlearning tools support attention, retention, and concept reinforcement.

Higher secondary students increasingly rely on digital microlearning tools for exam preparation, clarification of difficult concepts, and quick revision. However, the patterns of usage and factors that influence adoption remain understudiedespecially in the Indian school context. Understanding these factors is important for designing effective digital pedagogy aligned with National Education Policy 2020 (NEP 2020).

## Conceptual Framework

The conceptual framework guiding this study integrates three major theoretical perspectives: the Technology Acceptance Model (TAM), Bandura’s Self-Efficacy Theory, and the Resource Availability Model. The Technology Acceptance Model posits that users’ behavioural intention to adopt a digital tool is shaped primarily by their perceptions of its usefulness and ease of use. In the context of this study, these perceptions influence the extent to which students are willing to engage with digital microlearning tools in Biology. Complementing this, Self-Efficacy Theory emphasises the role of digital self-efficacystudents’ belief in their capability to effectively use digital platformswhich directly affects their confidence, persistence, and overall frequency of tool usage. Additionally, the Resource Availability Model highlights that students’ access to digital devices, reliable internet connectivity, and adequate academic or technical support significantly determines their ability to adopt and sustain the use of microlearning tools.

Drawing from these foundations, the framework focuses on three core constructs. The first construct, patterns of use, encompasses the frequency of engagement, preferred microlearning formats, and the duration of use. The second construct, predictors of usage, includes perceived usefulness, digital self-efficacy, learning motivation, and the availability of digital resources. The third construct identifies the outcome variable, defined as the overall extent of students’ use of digital microlearning tools in Biology.

The conceptual model proposes that the predictor variablesperceived usefulness, digital self-efficacy, learning motivation, and resource availabilitycollectively influence the degree to which students utilise microlearning tools. This relationship can be visually represented as a linear pathway where the predictor variables directly shape and determine students’ actual engagement with digital microlearning resources in Biology.

## Review of Related Studies

A review of national and international scholarship highlights growing interest in the pedagogical value of microlearning, particularly within science education. Global research consistently demonstrates that microlearning supports enhanced retention, increased motivation, and improved conceptual understanding among learners. Hug (2017) and Giurgiu

(2020) argue that short, focused learning unitssuch as learning nuggets, micro-videos, and flashcardspromote cognitive engagement and enable students to process complex scientific information more efficiently. In the specific context of Biology education, microlearning has been shown to facilitate the visualization of abstract or intricate biological processes, such as cell division, photosynthesis, and genetic mechanisms. More recent studies, including work by Kapp and Defelice (2022), reaffirm that microlearning formats align well with the cognitive load principles required for effective STEM learning.

Predictors influencing students' digital tool usage have also been extensively explored across educational technology research. Perceived usefulness remains one of the strongest determinants of learners' acceptance of digital platforms, as established in the extended Technology Acceptance Model (Venkatesh & Davis, 2000). Digital self-efficacy has emerged as a critical factor shaping students' confidence and willingness to use technology; Joo, Lim, and Kim (2018) found that adolescents with higher digital self-efficacy engage more frequently and more meaningfully with digital learning systems. Motivation likewise plays a crucial role, with foundational work by Schunk and Zimmerman (1998) and recent investigations such as Chang et al. (2022) demonstrating that intrinsic motivation significantly enhances voluntary digital engagement and sustained use of microlearning environments. Additional predictors, such as accessibility of digital devices, internet connectivity, and teacher guidance, further shape learners' digital engagement trajectories, as noted by Park and Jo (2021).

Within the Indian context, research on microlearning in school settings is steadily emerging. Studies conducted by Sharma and Singh (2023) and Raghavan (2022) highlight increased adoption of mobile-based microlearning components such as short educational videos, digital quizzes, and gamified Biology modules among high school students. These interventions have been associated with improved engagement and better preparatory outcomes for board examinations. However, despite rising digital uptake, systematic and large-scale quantitative investigations focusing specifically on microlearning practices in Biology classrooms remain limited. Existing studies are predominantly exploratory or qualitative, indicating a clear research gap that warrants empirical investigation. The present study seeks to address this gap by examining the predictors and patterns of digital microlearning tool usage among higher secondary Biology students.

## Objectives of the Study

1. To examine the patterns of digital microlearning tool use among higher secondary biology students.
2. To identify predictors influencing the use of microlearning tools.
3. To determine whether demographic variables (gender, school type) influence microlearning usage.

## Research Questions

1. What are the usage patterns of digital microlearning tools among higher secondary biology students?
2. What are the significant predictors of microlearning tool use?
3. Do gender and school type significantly influence usage levels?

## Hypotheses of the Study

H01: There is no significant difference in microlearning tool use between male and female students.
H02: There is no significant difference in microlearning tool use between government and private school students.
H03: Perceived usefulness, digital self-efficacy, learning motivation, and resource availability do not significantly predict microlearning tool use.

## Methodology of the Study

The present study employed a quantitative descriptive survey design, which is appropriate for systematically assessing patterns, predictors, and levels of digital microlearning tool usage among students. This design enables the collection of numerical data from a defined population with the purpose of describing current trends and relationships among key variables.

The population for the study consisted of all higher secondary science students enrolled in selected Darbhanga district, Bihar, India. From this population, a sample of 120 Biology students was drawn using a stratified random sampling technique to ensure adequate representation across gender and school types. The final sample comprised 58 male and 62 female students. This sampling approach enhanced the representativeness of the study and allowed for meaningful subgroup analyses within the quantitative framework.

## Tool of the Study and Data Analysis Procedure

A Digital Microlearning Usage Scale (DMUS) was developed for the purpose of this study to measure students' engagement with digital microlearning tools in Biology. The scale consists of five dimensions: frequency of use, perceived usefulness, digital self-efficacy, learning motivation, and availability of digital resources. All items were structured on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), enabling respondents to indicate the extent of their agreement with each statement.

The instrument underwent a rigorous validation process. Content validity was established through expert review, wherein five specialists in educational technology examined the items using a structured item-validation grid. The resulting Content Validity Index (CVI) of 0.89 indicated a high degree of relevance and clarity across the scale items. Reliability testing was conducted using Cronbach's Alpha, yielding a coefficient of 0.87, which reflects high internal consistency and suitability for quantitative analysis.

Data collection was carried out through a combination of Google Forms administration and in-person school visits, ensuring accessibility and comprehensive participant coverage. The collected data were analysed using a range of statistical techniques appropriate for the research objectives. Descriptive statistics were employed to summarise patterns of use, followed by inferential analyses including independent-sample t-tests, Pearson correlation coefficients, and multiple regression analysis to examine group differences, associations among variables, and predictive relationships, respectively.

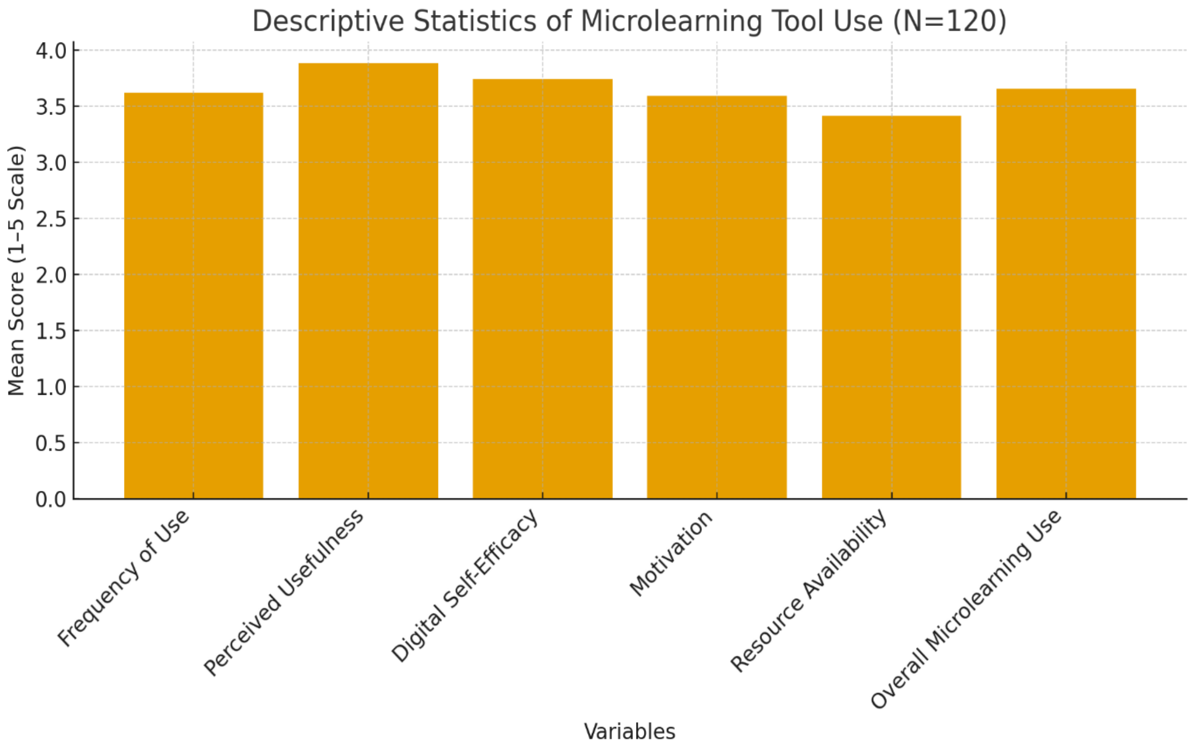


## Data Analysis and Interpretation

**Table 1: Descriptive Statistics of Microlearning Tool Use (N=120)**

| Variable | Mean | SD | Level |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Frequency of Use | 3.62 | 0.71 | Moderate |
| Perceived Usefulness | 3.88 | 0.65 | High |
| Digital Self-Efficacy | 3.74 | 0.68 | High |
| Motivation | 3.59 | 0.72 | Moderate |
| Resource Availability | 3.41 | 0.77 | Moderate |
| Overall Microlearning Use | 3.65 | 0.66 | Moderate-High |




**Interpretation:**The descriptive statistics presented in Table-1 provide a comprehensive overview of students' engagement with digital microlearning tools in Biology. The findings indicate that overall microlearning tool use falls within the moderate-to-high range (M =

3.65, SD = 0.66), suggesting that students are generally receptive to integrating short, technology-mediated learning resources into their study routines.

Among the five measured dimensions, perceived usefulness recorded the highest mean score (M = 3.88, SD = 0.65), reflecting a strong belief among students that microlearning tools contribute meaningfully to their understanding of Biology concepts. This high level of perceived usefulness is consistent with existing literature emphasising its central role in technology adoption. Digital self-efficacy also scored high (M = 3.74, SD = 0.68), indicating that most students feel confident in their ability to navigate digital learning tools; a factor that likely facilitates more frequent and effective usage.

Moderate levels of engagement were observed in frequency of use (M = 3.62, SD = 0.71) and learning motivation (M = 3.59, SD = 0.72). These results suggest that although students recognise the value of microlearning, their actual usage patterns may be influenced by competing academic demands, personal study habits, or inconsistent exposure to digital microlearning resources within the curriculum.

The lowest mean score was recorded for resource availability (M = 3.41, SD = 0.77), indicating that access to devices, internet connectivity, and supportive digital infrastructure remains uneven. This finding highlights a persistent digital divide that may restrict some students from fully benefiting from microlearning opportunities.

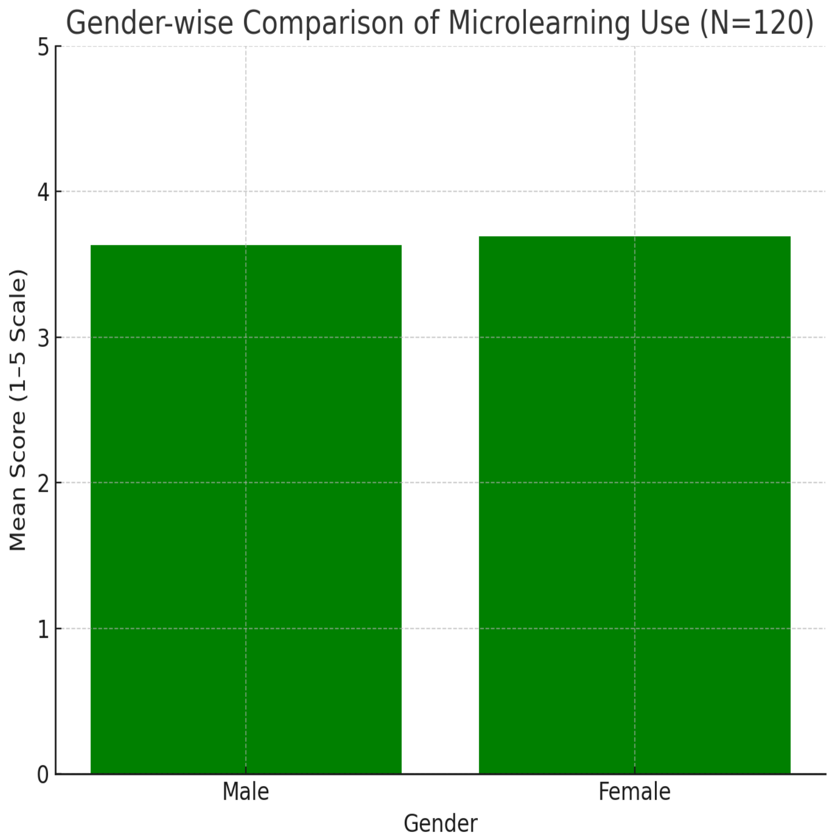
Taken together, the descriptive results reveal a generally positive orientation toward digital microlearning, shaped by strong perceived usefulness and self-efficacy, but moderated by structural limitations in resource availability and moderate levels of actual use and motivation. These patterns underscore the need for targeted interventions aimed at strengthening digital infrastructure and integrating microlearning more systematically into Biology instruction.



**Table 2: Gender-wise Comparison (t-test)**

| Gender | N | Mean | SD | t-value | p-value |
|---|---|---|---|---|---|
| Male | 58 | 3.63 | 0.68 | 1.12 | 0.263 |

| | | | | | |
|---|---|---|---|---|---|
| Female | 62 | 3.69 | 0.64 | | |

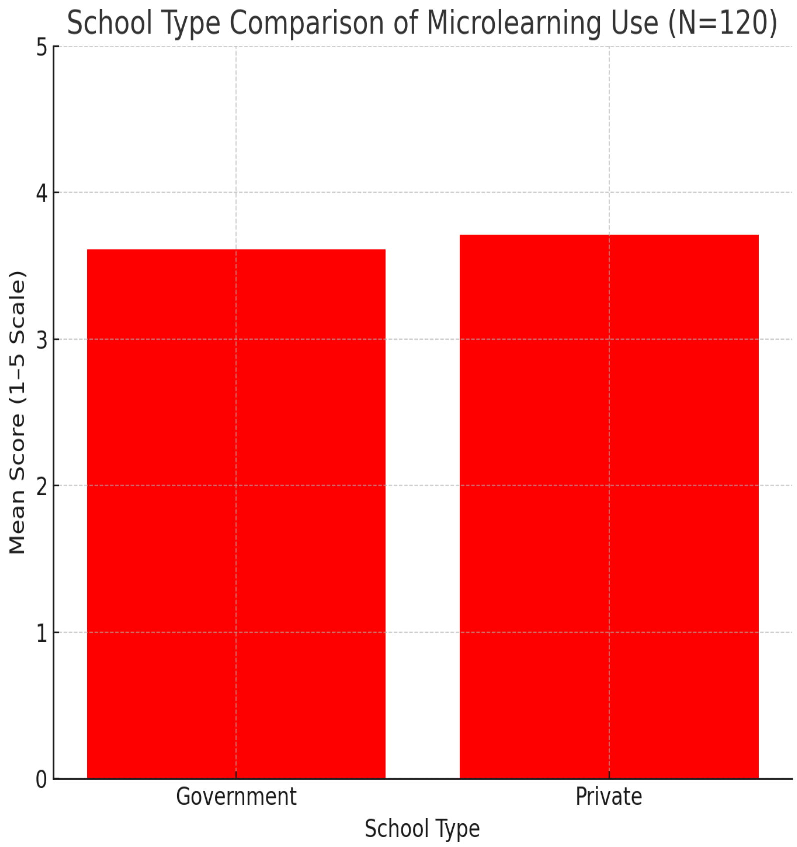



**Interpretation:**The results of the genderwise comparison presented in Table-2 indicate that both male and female students report similar levels of digital microlearning tool use in Biology. Male students recorded a mean score of 3.63 (SD = 0.68), while female students reported a slightly higher mean of 3.69 (SD = 0.64). To determine whether this difference was statistically significant, an independent samples t-test was conducted. The analysis yielded a t-value of 1.12 with an associated p-value of 0.263, which is well above the conventional significance threshold of 0.05.

These findings suggest that there is no statistically significant difference between male and female students in their use of digital microlearning tools. Although female students show marginally higher engagement, the difference is not substantial enough to indicate a gender-based disparity. This result aligns with recent literature indicating that gender differences in digital learning environments have diminished as access to devices and digital literacy skills become more evenly distributed among students. Overall, the findings imply that both male and female learners engage with microlearning tools at comparable levels, highlighting the gender-neutral nature of digital microlearning adoption in Biology education.

**Table 3: School Type Comparison**

| School Type | N | Mean | SD | t-value | p-value |
|---|---|---|---|---|---|
| Government | 80 | 3.61 | 0.69 | 1.48 | 0.139 |
| Private | 40 | 3.71 | 0.62 | | |



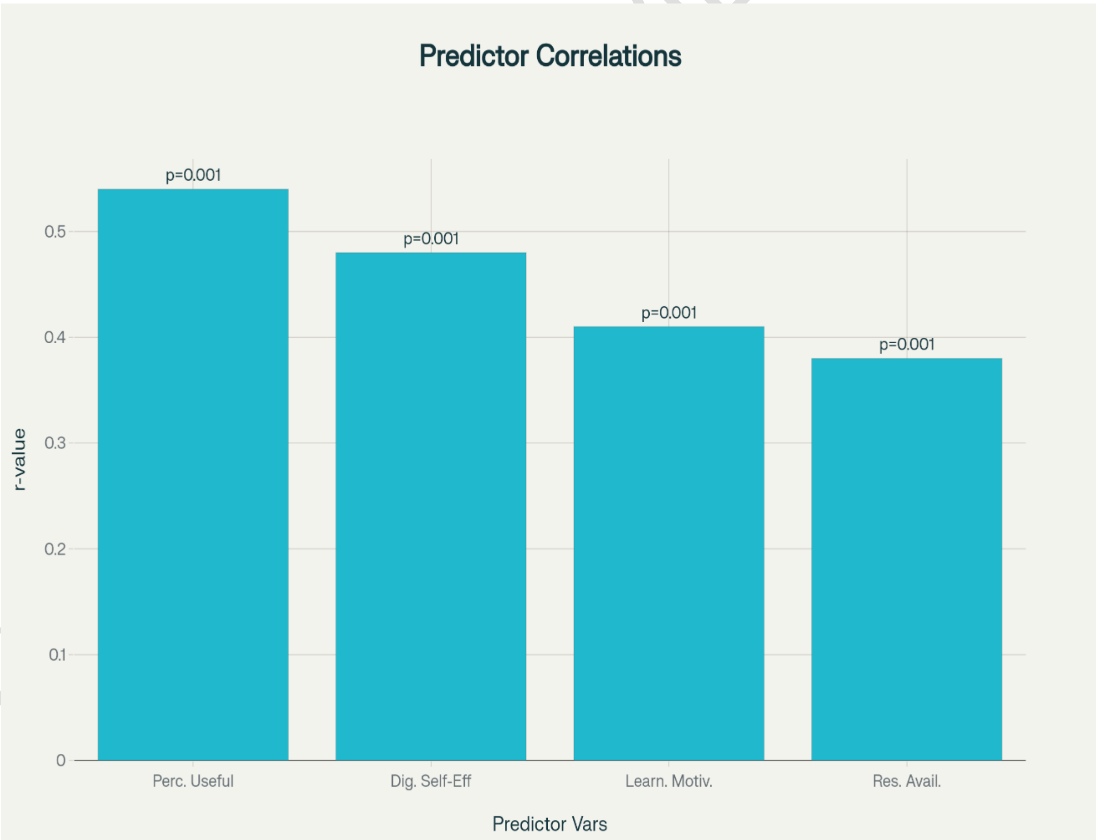

**Interpretation:**The results presented in Table-3 compare the extent of microlearning tool use among students from government and private schools. Government school students reported a mean score of 3.61 (SD = 0.69), while private school students demonstrated a slightly higher mean of 3.71 (SD = 0.62). To examine whether this difference was statistically meaningful, an independent samples t-test was conducted. The obtained t-value of 1.48 with a corresponding p-value of 0.139 indicates that the difference in mean scores is not statistically significant at the 0.05 level.

This finding suggests that students across both school types engage with digital microlearning tools at comparable levels. Despite private school students showing a marginally higher mean score, the absence of statistical significance implies that school type does not play a decisive role in determining microlearning tool adoption in Biology.

Consequently, the study fails to reject the null hypothesis (H02), which posits no significant difference between government and private school students. These results reflect the increasing diffusion of digital learning practices across diverse school settings, potentially due to wider smartphone access, government initiatives promoting digital education, and the growing availability of low-cost educational apps accessible to students irrespective of school type.

**Table 4: Correlation Between Predictors and Microlearning Use**

| Variable | r-value | p-value |
|---|---|---|
| Perceived Usefulness | 0.54 | 0.001* |
| Digital Self-Efficacy | 0.48 | 0.001* |
| Learning Motivation | 0.41 | 0.001* |
| Resource Availability | 0.38 | 0.001* |




**Interpretation:**Table-4 presents the correlation coefficients between the predictor variables and students' use of microlearning tools in Biology. The results indicate that all four predictorsperceived usefulness, digital self-efficacy, learning motivation, and resource availabilityare positively and significantly associated with microlearning usage at the 0.001 significance level.

Among the predictors, perceived usefulness shows the strongest correlation ($r = 0.54$, $p = 0.001$), suggesting that students who believe microlearning tools enhance their understanding are more likely to use them frequently. Digital self-efficacy also demonstrates a robust positive relationship ($r = 0.48$, $p = 0.001$), indicating that confidence in one's ability to operate digital tools plays a substantial role in shaping usage patterns.

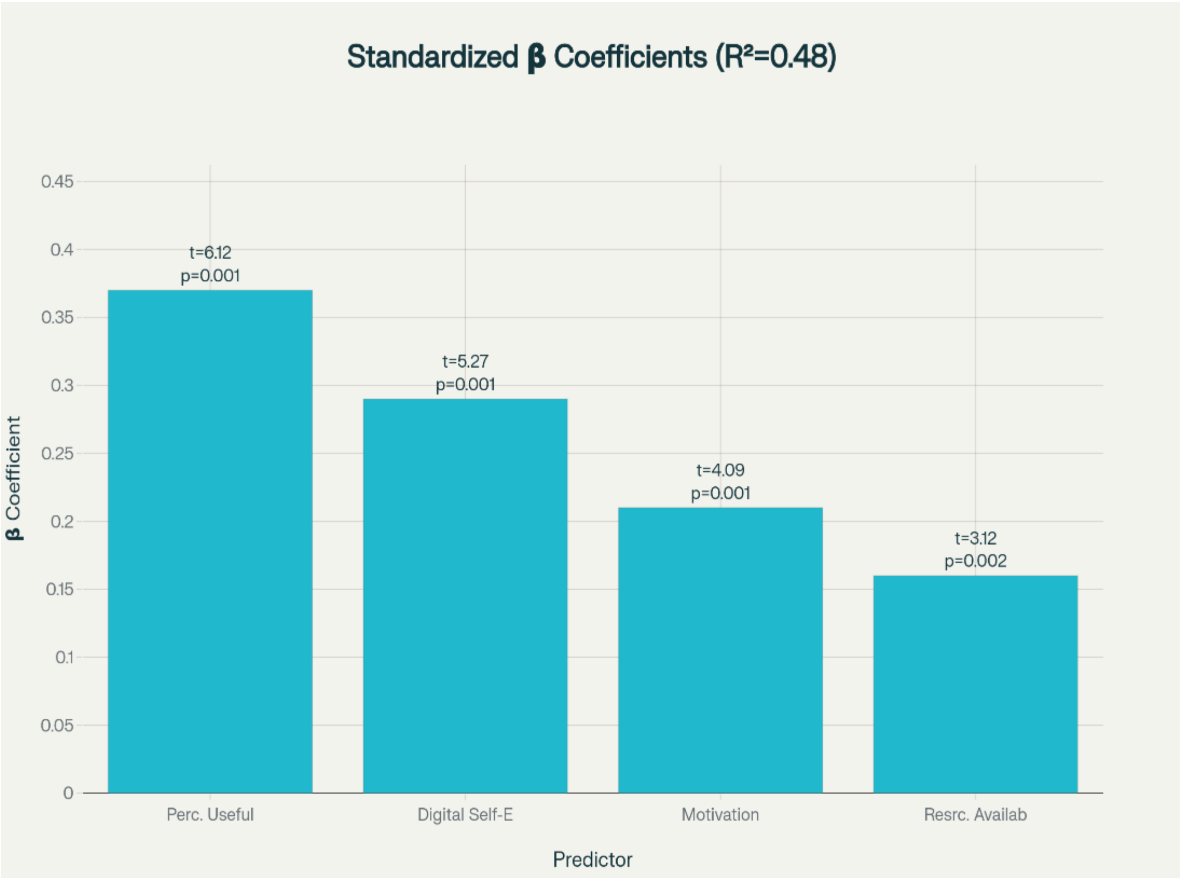
Learning motivation exhibits a moderate yet significant positive correlation ($r = 0.41$, $p = 0.001$), implying that motivated learners tend to engage more readily with microlearning resources. Similarly, resource availability ($r = 0.38$, $p = 0.001$) shows a positive association, highlighting that access to devices, internet connectivity, and supportive digital infrastructure contributes to increased microlearning tool use.

Thus, the correlation analysis confirms that all predictor variables meaningfully support students' engagement with digital microlearning tools. These findings reinforce the theoretical assumptions of the Technology Acceptance Model and Self-Efficacy Theory, which emphasize the roles of perceived usefulness, confidence, and contextual support in technology adoption.

**Table 5: Regression Analysis**

| Predictor | β | t-value | p-value |
|---|---|---|---|
| Perceived Usefulness | 0.37 | 6.12 | 0.001* |
| Digital Self-Efficacy | 0.29 | 5.27 | 0.001* |
| Motivation | 0.21 | 4.09 | 0.001* |
| Resource Availability | 0.16 | 3.12 | 0.002* |

**$R^2 = 0.48 \rightarrow 48\%$ variance explained**




**Interpretation:**The regression analysis presented in Table 5 examines the predictive power of four key variablesperceived usefulness, digital self-efficacy, learning motivation, and resource availabilityon students' use of microlearning tools in Biology. The model explains 48% of thevariance in microlearning usage ($R^2 = 0.48$), indicating a substantial level of explanatory power within the educational context.

Among the predictors, perceived usefulness emerges as the strongest and most significant predictor ($\beta = 0.37$, $t = 6.12$, $p = 0.001$), demonstrating that students' belief in the academic value and relevance of microlearning directly influences their level of engagement. Digital self-efficacy also shows a strong predictive effect ($\beta = 0.29$, $t = 5.27$, $p = 0.001$), reinforcing the importance of confidence and competence in shaping digital learning behaviours.

Learning motivation contributes significantly to predicting microlearning tool use ($\beta = 0.21$, $t = 4.09$, $p = 0.001$), suggesting that students who are intrinsically motivated are more likely to adopt and consistently utilise microlearning resources. Resource availability ($\beta = 0.16$, $t = 3.12$, $p = 0.002$) exerts a smaller yet statistically meaningful influence, indicating that access to digital devices and reliable connectivity remains relevant, though less influential than cognitive and attitudinal factors.

So, these findings highlight that students' perceptions, confidence, and motivation play central roles in shaping microlearning engagement, while infrastructural support provides an enabling environment. Given the strong and significant effect of perceived usefulness, the study rejects the null hypothesis (H03) and concludes that perceived usefulness is the most dominant predictor of microlearning tool use among higher secondary Biology students.

## Major Findings of the Study

- Students show moderatetohigh use of digital microlearning tools in Biology.
- Videos and interactive quizzes are the most frequently used formats.
- Perceived usefulness, digital self-efficacy, motivation, and resource availability significantly predict usage.
- Gender does not influence usage.
- School type does not influence usage.
- Predictors explain 48% of variance in microlearning tool usage.

## Discussion

The findings support earlier research showing high acceptance of microlearning tools among science learners. Students prefer concise learning formats aligned with attention span theories. The strong predictive role of perceived usefulness aligns with TAM, indicating students adopt tools they believe improve academic performance.

Digital self-efficacy also emerged as a key determinant, suggesting the need for digital literacy interventions. The insignificant effect of gender and school type indicates microlearning adoption is becoming universal, irrespective of institutional differences.

## Educational Implications

- Integrate microlearning formally into biology curriculum for concept reinforcement.
- Enhance digital self-efficacy through ICT training and guided practice.

- Provide device and internet access, especially in government schools.
- Train biology teachers to design microlearning modules aligned with NEP 2020.
- Use microlearning tools for revision, flipped learning, and remedial teaching.

## Conclusion

The study concludes that microlearning tools hold strong potential for enhancing biology learning at the higher secondary level. The results reaffirm that students increasingly prefer short, focused learning segments that align with contemporary theories on attention span and cognitive processing. The significant influence of perceived usefulness highlights that students are more inclined to adopt digital microlearning tools when they believe these tools genuinely support their academic performance, consistent with the Technology Acceptance Model (TAM). Digital self-efficacy also emerged as an important factor, underscoring the need for continuous digital literacy support to help students navigate and benefit from modern learning technologies. Furthermore, the non-significant differences across gender and school type suggest that microlearning adoption is becoming widespread and equitable, reflecting a universal shift in students' learning preferences.

Overall, these findings emphasize the importance of integrating microlearning strategies into the biology curriculum to strengthen conceptual understanding. Schools must focus on improving digital competencies, ensuring adequate access to devices and internet facilities, and training biology teachers to design microlearning modules that align with NEP 2020. When implemented effectively, microlearning can serve as a powerful tool for revision, flipped classroom practices, and remedial learning, ultimately contributing to improved learning outcomes and more engaging science education.

## References

1. Bandura, A. (1997). *Self-efficacy: The exercise of control*. W.H. Freeman.
2. Chang, C., Liu, E., & Chen, T. (2022).Exploring the influence of intrinsic motivation on students' engagement in digital and microlearning environments. *Journal of Educational Technology & Society, 25*(3), 45-59.
3. Giurgiu, L. (2020). Microlearning an evolving educational approach. *Journal of E-Learning Research*, 1(1), 1-6.

4. Government of India. (2020). *National Education Policy 2020*. Ministry of Human Resource Development, Department of Higher Education. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
5. Hug, T. (2017). Didactics of microlearning: Concepts, discourses, and examples. *Zeitschrift für Hochschulentwicklung*, 12(4), 235-256.
6. Joo, Y. J., Park, S., & Lim, E. (2018). The effects of digital literacy on learning outcomes. *Educational Technology & Society*, 21(4), 230-241.
7. Kapp, K. M., & Defelice, R. A. (2022).*Microlearning: Short and focused strategies for learning in the digital age* (2nd ed.). Association for Talent Development.
8. Park, Y., & Jo, I. (2021).Factors influencing students' digital engagement: The role of device accessibility, connectivity, and instructional support. *International Journal of Educational Research, 108*, 101786.
9. Raghavan, S. (2022).Adoption of microlearning practices among Indian higher secondary students: A study on digital readiness and classroom integration. *Indian Journal of Educational Technology*, *10*(2), 55-68.
10. Schunk, D. H., & Zimmerman, B. J. (1998). *Self-regulated learning: Theories, measures, and outcomes*. Academic Press.
11. Schunk, D. H., & Zimmerman, B. J. (1998).Self-regulated learning: From teaching to self-reflective practice. *Educational Psychologist*, *33*(2-3), 73-86.
12. Sharma, R., & Singh, S. (2023). Adoption of digital learning tools in Indian secondary schools. *Indian Journal of Educational Research*, 12(2), 45-57.
13. Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model. *Management Science*, 46(2), 186-204.