Integration of Adaptive Microlearning in Secondary Education

Maha Alhadi Mahmoud Attia[1]; Mabruka Almasoudi Abdalraheem Ahmed[2]; Ltfei Ahmed A Abdalsmd[3]

[1,2] Assistant Lecturer, [3]Assistant Professor, Department of Computer Science, Faculty of Arts and Sciences, Elmergib University, Msallata, Libya

Publication Date: 2025/01/24

Abstract
Recent research has shown that the pandemic has catalyzed significant changes in secondary education. As societal and educational systems evolve alongside rapid technological advancements, alterations in educational practices are unavoidable. In this evolving educational environment, meeting the varied needs of high school students requires innovative strategies. This paper explores the importance of incorporating adaptive microlearning into high school curricula to improve learning outcomes. Adaptive microlearning, which delivers personalized, bite-sized content aligned with individual learning styles, addresses the limitations of conventional education models. This method acknowledges the distinct cognitive and developmental phases of high school learners, providing a flexible and engaging structure that promotes active participation. Moreover, the paper includes a case study from the high school sector. It will utilize student feedback and data collected throughout the semester, focusing on behavioral analysis and genuine learning motivations, to refine the proposed system. Further pedagogical investigation is crucial to validate enhancements in students' educational experiences.

Keywords: *Adaptive E-Learning, Microlearning, Adaptive Microlearning, Secondary Education.*

I. INTRODUCTION

Secondary education is required to adapt to the challenges posed by technological advancements and societal shifts. With the entry of Generation Alpha students into high school, new requirements must be addressed, as their learning expectations differ from those of earlier generations [1]. Numerous studies suggest that the type of educational support suitable for Generation Alpha may not align with what previous generations required. This generation seeks learning experiences that are tailored to their preferences and easily accessible from any device, at any time and place. Notably, some changes within higher education have already emerged, particularly during the pandemic, as highlighted by Global High School Education Research in [2]. In response to the pandemic, many high school institutions have begun to adopt or plan to implement more flexible learning options regarding when and how students can engage in learning.

A critical question arises: which teaching methods and tools could effectively restructure courses to achieve noticeable outcomes? To facilitate this necessary evolution of the educational process, one effective strategy for enhancing the learning efficiency of Generation Alpha is the incorporation of microlearning alongside traditional teaching methods. Various studies indicate that microlearning, which aligns with contemporary students' learning and retention patterns, can lead to improved educational results. In recent years, there has been a growing inclination to utilize microlearning in educational settings. However, for this approach to be effective, it must enable individualized knowledge enhancement while simultaneously charting the best course toward educational objectives.

Generation Alpha tends to prioritize speed over precision. To boost students' efficiency, adopting microlearning can be beneficial as it allows them to learn anytime, anywhere, on any device. The authors of this paper have successfully integrated microlearning into their teaching practices. In [3], they detailed their practical experience in developing an adaptable e-learning system that employs fuzzy logic to assess and model students' knowledge for personalized adaptation in Computer Programming. This fuzzy logic technique was implemented as a plugin within the MOODLE Learning Management System at the Libyan Academy for Postgraduate Studies.

The aim of this paper is to investigate how adaptive microlearning can tackle learning challenges and enhance the educational experiences of high school students. The authors propose a personalized learning system that utilizes microlearning and is designed to guide students based on their individual learning needs, thereby increasing their engagement while bridging gaps in prior knowledge. The paper begins by outlining the research methodology employed by the authors. It then provides a thorough introduction to microlearning and adaptive microlearning. Subsequent sections contextualize adaptive microlearning within the broader learning and teaching landscape and delve into a specific application in a computer science course. Finally, the paper discusses future research directions and draws conclusions, emphasizing the potential of adaptive microlearning to revolutionize high school education by offering customized solutions that cater to the requirements of contemporary learners.

II. METHODOLOGY

The authors of this paper seek to explore several research questions related to the concept of microlearning:

- Q1: What constitutes microlearning?
- Q2: How is microlearning utilized in high school education?
- Q3: To what degree can microlearning be effectively implemented for high school students?

As a relatively recent development in e-learning, significant advancements have been made regarding its application within high schools over the past few years. Therefore, evaluating its appropriateness for particular contexts is essential.

III. CASE STUDY

The topic discussed here is a mandatory course designed for second-year high school students within the science curriculum. This course spans an entire academic year, divided into two semesters over six months. In light of the prevalence of the internet and social media, there has been a significant shift towards online studying among students. They utilize various social media platforms to access lessons, summaries, and guiding questions related to their studies. The subject encompasses several prerequisite knowledge areas acquired from previous courses taken in earlier academic years at both middle and high school levels. Our primary objective is to pinpoint any weaknesses in students' grasp of different concepts within computer science and address these through tailored informational content "packages." We believe that this method will enhance student comprehension of the material, leading to more effective learning outcomes.

In our microlearning strategy, recognizing gaps in student understanding plays a vital role. These gaps may result either from inadequate comprehension of essential concepts necessary for success in the current coursework or from missing foundational knowledge that was not introduced during prior education due to various factors such as insufficient instruction. Every advanced topic requires certain prerequisites; thus, it is crucial for learners to have a firm grounding in basic principles since some subjects serve as prerequisites for others. All potential knowledge deficits are identified and addressed by consistently implementing these steps:

- Detect deficiencies relating to prerequisite skills needed for computer science,
- Supply relevant information addressing identified issues,
- Confirm that students comprehend this critical information so they can effectively build upon new insights.

It’s imperative we identify any potential shortcomings regarding understanding key aspects presented throughout the course material. After completing an evaluation process, based on grades received along with incorrect answers noted by our system, each student will be categorized into one of three classifications: pass, pass with remediation needs or fail status indicating insufficient mastery of fundamental prerequisites if their score falls below an established minimum threshold. this classification initiates subsequent actions wherein suitable microlearning modules—such as instructional videos or pre-designed projects—are provided aimed specifically at rectifying identified topics needing attention. Conversely:

If scores exceed maximum thresholds indicating strong competency without need for additional support—they may continue progressing through standard coursework. Scores falling between specified limits suggest moderate concerns requiring remedial efforts while still reflecting overall sound comprehension level which allows recommending improvements tied directly back onto individual responses—all without necessitating further evaluations thereafter since autonomous study opportunities remain accessible whenever desired across all available units at anytime/anyplace convenience offered up freely unto every learner involved.

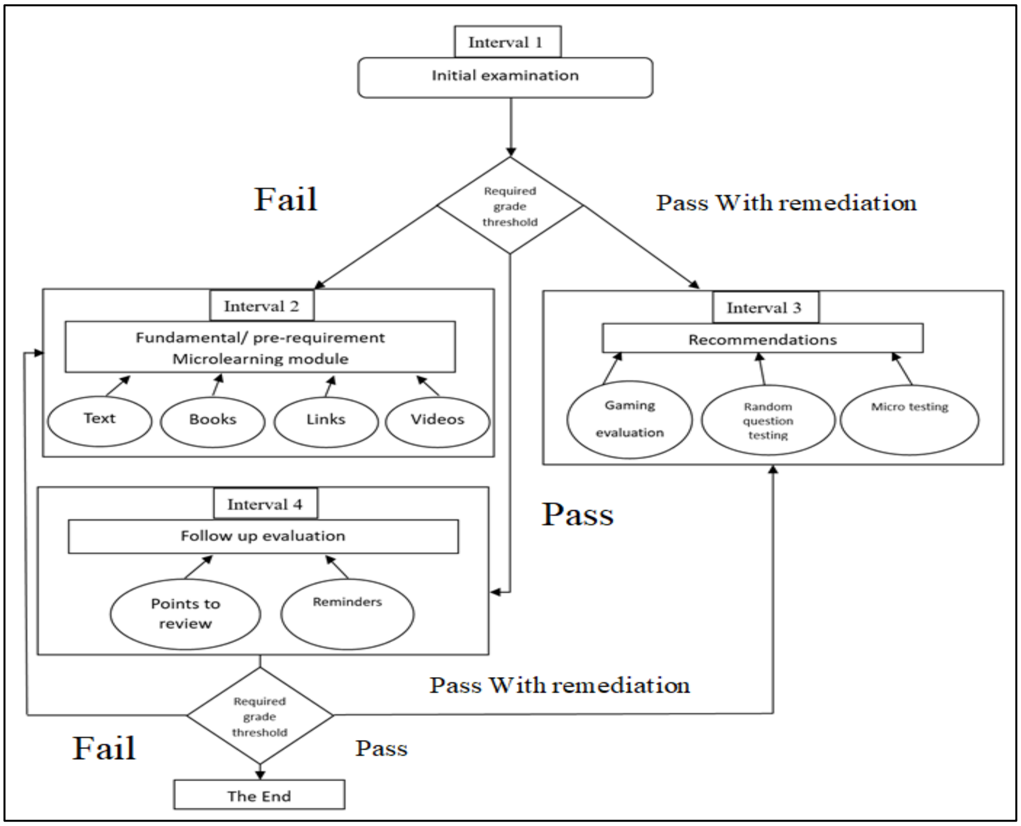

Fig. 1. The Flowchart of the Proposed Solution

In the second phase, if a student does not succeed on the test, it is necessary to select and present an appropriate microlearning unit. Following this, the student must pass a subsequent evaluation; failure to do so will require them to revisit the unit until they achieve mastery of the content. The follow-up assessment can take various forms such as gamified experiences, random question tests, multiple-choice assessments, or brief quizzes. With each attempt at this evaluation, students are categorized into one of three groups: fail (indicating that they need to retake the microlearning unit), pass (which allows progression with standard course materials), or pass with remediation. In instances where remediation occurs, feedback highlighting incorrect responses will be provided by a recommendation engine focusing specifically on areas for improvement. This feedback identifies what needs review and establishes periodic reminders until learning objectives are met.

Central to our system is this feedback engine which offers recommendations designed to facilitate more efficient and effective study practices for students. This system serves as a bridge between essential requirements and gaps in knowledge identified within individual learners' understanding.

One effective strategy employed here involves mind maps—an approach demonstrated through research [20][21] as particularly advantageous for students engaged in technical disciplines characterized by vast amounts of information. Numerous e-learning tools leverage mind maps for structuring content clearly and logically while forming connections that enhance comprehension [22]. Experimental findings support their efficacy within e-learning environments [23]. Mind maps enable us to visually organize related concepts in ways comprehensible both intuitively by people and systematically by machines.

A mind map illustrates key elements pertaining to computer components alongside prerequisites crucial for grasping these fundamentals effectively. This methodology exhibits high versatility since it communicates processes efficiently across human users and machine systems alike. Once constructed, diagrams remain accessible for student interpretation while simultaneously being suitable for machine analysis—a process allowing parsing into graphs followed by programmatic examination. The recommendation engine leverages these mind maps strategically aligning microlearning units with relevant categories based upon recognized deficiencies in knowledge levels among students' profiles. Recommendations arise similarly from associations discerned via mapping techniques; when a student's score falls within specific predefined thresholds the recommendation mechanism activates automatically recording pertinent details internally including learner ID numbers along with event dates connected directly back towards suggested topics aimed at further exploration during subsequent lessons. To protect privacy throughout participation processes however—they remain anonymous ensuring no biases interfere whilst still permitting tracking educational advancements over time leading toward personalized instructional pathways tailored uniquely according each individual's detected learning trajectory.

Maintaining logs also enables an additional function regarding quality assessment concerning course contents themselves—as highly recommended units indicate strong interest thus necessitating rigorous attention paid towards accuracy relevance clarity segmentation therein accordingly. Students can express opinions about helpfulness overall quality succinctly without requiring extensive questionnaires simplifying collection methods enabling quicker identification rework restructuring targeted sections needing enhancement ultimately refining future iterations continuously improving outcomes experienced collectively.

IV. RESULTS AND DISCUSSION

The main focus in educating students revolves around their ability to effectively absorb the material provided. To explore this, we sought to assess how our proposed system influences student learning outcomes. Tests created to aid learning are accessible online, enabling each student to evaluate themselves via the website. Furthermore, the knowledge gained from a microlearning module is confirmed through a practical assessment. Feedback from students indicates that a majority of participants found satisfaction with their educational experience offered by microlearning. In order to comprehensively examine both the advantages and challenges associated with our proposed approach, we implemented two methods for assessing student performance. The understanding of newly acquired knowledge was measured using automatically scored multiple-choice questions. Data collected over two consecutive semesters from different cohorts of second-year students enrolled in this computer course revealed notable enhancements in comprehension.

Additionally, students were tasked with individually demonstrating their grasp of new concepts by creating software applications as part of their homework assignments. These projects were evaluated by instructors according to identical grading criteria used in previous years. A comparison between current student grades and those from prior years showed statistically significant improvements in academic results based on data compiled over three successive years. It is important to highlight that at the time this paper was written, only an initial evaluation had been conducted regarding overall learning; final grades encompassing all activities during the first semester and results from end-of-term examinations were not included in this analysis yet. Despite these limitations, preliminary findings support that our proposed system serves as an effective tool for managing microlearning initiatives and motivates us towards continued investigation into its efficacy.

V. FURTHER WORK

For future research, we suggest that this approach could be expanded to other STEM subjects, which would enhance educational outcomes across various technical fields. Establishing a platform that is user-friendly for teachers and beneficial for students could promote the adoption of microlearning techniques and methods as effective teaching tools.

VI. CONCLUSION

In recent years, secondary education has evolved significantly to adapt to new generations of students, labor market demands, and emerging technologies. The pandemic highlighted a gap between digital technologies and education, while also accelerating the shift towards digital education. The current challenge is integrating new technologies into existing learning contexts to ensure high-quality education for all. As a result, teachers can no longer rely solely on traditional teaching methods. Generation Alpha values speed over accuracy, necessitating more efficient learning methods like microlearning, which allows students to learn anytime, anywhere, and on any device. Various publications suggest that microlearning will play a growing role in future educational processes. Despite significant progress, effectively utilizing microlearning units in secondary education remains challenging. This paper presents our experience with microlearning in a computer science course. The microlearning units were designed to quickly familiarize students with computer science concepts. We provided students with a structured map of microlearning units for the course, balancing convenience and essential content. Additionally, each student received personalized recommendations on which microlearning units to focus on, tailored to their individual learning paths. However, active participation in the proposed activities is crucial for developing key computer science skills. The positive outcomes of using adaptive microlearning could inspire other educators to reconsider traditional class structures to boost student motivation.

REFERENCES

[1]. * "Generation Z", Center for Innovative Teaching and Learning, Instructional Guide, Northern Illinois University, 2020, Available at: https://www.niu.edu/citl/resources/guides/instructional%20guide/generation-z.shtml.

[2]. * "The Evolution of Higher Education: 5 Global Trends to Watch", Global Higher Education Research Salesforce.org, November 2020, Available at: https://www.visualcapitalist.com/the-evolution-of-higher-education-5-global-trends-to-watch/.

[3]. M. Attia and M. Arteimi, "Adaptive E-Learning System using Fuzzy Logic", Master thesis, Libyan Academy, 2021.

[4]. Andriotis, N., "Everything you wanted to know about microlearning (but were afraid to ask)", 2016, Available at: https://www.efrontlearning.com.

[5]. Hug, Theo, and Norm Friesen, "Outline of a Microlearning Agenda", Didactics of Microlearning. Concepts, Discourses and Examples, 15–31, 2007.

[6]. Hug, T., "Micro Learning and Narration. Exploring possibilities of utilization of narrations and storytelling for the designing of 'micro units' and didactical micro-learning arrangements", In: Fourth Media in Transition conference, 2005.

[7]. Hug, T., "Micro Learning and Narration", In Fourth Media in Transition Conference, May (pp. 6-8). Cambridge: MIT Press, 2005.

[8]. Buchem, I. and Hamelmann, H., “Microlearning: a strategy for ongoing professional development”, eLearning Papers, Vol. 21 No. 7, pp. 1-15, 2010.

[9]. Said, I. and Çavuş, M., “ALU design by VHDL using FPGA technology and micro learning in engineering education”, British Journal of Computer, Networking and Information Technology, Vol. 1 No. 1, pp. 1-18, 2018.

[10]. Buhu, A. and Buhu, L., "The Applications of Microlearning in Higher Education in Textiles", eLearning and Software for Education, Vol. 3, pp. 373-376, 2019.

[11]. Dolasinski, M. J., & Reynolds, J., "Microlearning: A New Learning Model", Journal of Hospitality & Tourism Research, 44(3), 551-561, 2020.

[12]. Wang, C., Bakhet, M., Roberts, D., Gnani, S., & El-Osta, A., "The efficacy of microlearning in improving self-care capability: a systematic review of the literature", Public Health, 186, 286-296, 2020.

[13]. Gawlik, K., Guo, J., Tan, A., & Overcash, J., "Incorporating a Microlearning Wellness Intervention Into Nursing Student Curricula", Nurse Educator, 46(1), 49-53, 2020.

[14]. De Gagne, J.C., Park, H.K., Hall, K., Woodward, A., Yamane, S. and Kim, S.S., “Microlearning in health professions education: scoping review”, JMIR Medical Education, Vol. 5 No. 2, 2019.

[15]. De Gagne, J.C., Woodward, A., Park, H.K., Sun, H. and Yamane, S.S., “Microlearning in health professions education: a scoping review protocol”, JBI Database of Systematic Reviews and Implementation Reports, Vol. 17 No. 6, pp. 1018-1025, 2019.

[16]. Allela, M. A., Ogange, B. O., Junaid, M. I., & Charles, P. B., "Effectiveness of Multimodal Microlearning for In-service Teacher Training", Journal of Learning for Development, 7(3), 384-398, 2020.

[17]. Leong, K., Sung, A., Au, D., Blanchard, C., "A review of the trend of microlearning", Journal of Work Applied Management, 2020.

[18]. Sun, G., Cui, T., Beydoun, G., Chen, S., Dong, F., Xu, D., & Shen, J., "Towards Massive Data and Sparse Data in Adaptive Micro Open Educational Resource Recommendation: A Study on Semantic Knowledge Base Construction and Cold Start Problem", Sustainability, 9, 898, 2017. https://doi.org/10.3390/su9060898.

[19]. J. Lin, G. Sun, J. Shen, T. Cui, P. Yu, D. Xu, et al., "A Survey of Segmentation Annotation and Recommendation Techniques in Micro Learning for Next Generation of OER", 2019 IEEE 23rd International Conference on Computer Supported Cooperative Work in Design (CSCWD), pp. 152-157, 2019.

[20]. Yu, W., Wang, Q., Jia, G., Gao, Z., Zhao, C., "Application of Mindmap in the Teaching of Cell Biology of Medical Students", DEStech Transactions on Social Science, Education and Human Science, 10.12783/dtssehs/meit2017/12824, 2017.

[21]. Lee, H.J. & Messom, C.H., "Adapting engineering education for a mindmap-based digital textbook: To reduce the skill gap between what the industry demands and what academia delivers", pp. 916-924, 2011.

[22]. Gao, N., and Li, L., "The Curriculum Integration Thought Based on the Mindmap", Proceedings of the Fifth International Symposium – Education Management and Knowledge Innovation Engineering, pp. 274-277, 2012.

[23]. Jiang, Z. Y., "The Empirical Research of Network Teaching System Based on Webquest and Mindmap", Mechanics and Materials, 475–476, 1235–1239, 2013. https://doi.org/10.4028/www.scientific.net/amm.475-476.1235.