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# Integrating Cloud Storage in STEM Education: A Case Study on Collaborative Project-Based Learning

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**Abstract**

When science, technology, engineering, and mathematics (STEM) are combined, these topics provide children with the knowledge and skills they need to become intelligent, responsible adults. The primary teaching approach used in this research was Project-Oriented Problem-Based Learning (Po-PBL), which examined the effects of an integrated STEM education system on students' 21st-century competencies. A one-group quasi-experimental methodology and polling techniques were used to assess the students' understanding before and after the program began. The findings demonstrated that pupils' overall 21st-century abilities significantly improved. This was particularly true for their production skills, which improved from mediocre to excellent. Because Po-PbL requires students to focus on real-life issues and discover answers, it is evident that it is particularly beneficial for students in STEM areas. The research emphasizes the value of incorporating Po-PbL into STEM education to assist students in improving their problem-solving, creativity, teamwork, and communication skills. When students work on projects with their hands, they use what they already know and discover new things. These abilities will help students deal with a challenging situation in the future.

***Keywords:*** *Cloud Storage, STEM, Education, Project-Based Learning.*

## 1. Introduction

Science, technology, engineering, and mathematics (STEM) [1] education is a modern teaching method that combines skills and knowledge in these areas. This method has gotten more attention because it aims to make a few fields easier to understand, incorporate their ideas, and keep up with changes and discoveries in math, science, engineering, and technology. STEM education meets the needs of the twenty-first century's global job market and the workforce's needs in these fields [10]. Teaching STEM classes is one of the most essential parts of the current changes to education. The National Science Foundation (NSF) [9] started the STEM initiative in the 1990s by creating curricula and courses in these four fields. The STEM initiative's structure has changed over time to meet the needs and interests of people who work in STEM fields. The curriculum has been expanded to include new subjects like psychology, computer science, information studies, sociology, finance, and politics. The STEM approach is an essential trend in science and technology education [12]. It wants to improve and update how math, physics, and technical design are taught. This reorganisation is meant to help students deal with the problems and challenges they face every day, as well as the needs of the global economy and the job market. STEM Project-Based Learning (PBL) [3] is one way to teach STEM that puts students' interests and skills first [2]. STEM PBL enhances students' analytical and social competencies by customising the educational experience to accommodate diverse learning styles [4]. It gives students the drive they need to solve real-world problems, which helps them learn more in the classroom [13]. This method will help learners positively impact future STEM learning by letting them work at their own speed [6].

The two primary goals of STEM education in Uzbekistan are to make people who can compete globally and shift the scientific and technical civilisation [5]. This means giving students the tech and science skills they need to help society and succeed globally [8]. One major obstacle to reaching these goals is that Saudi students lose research interest.

This study aimed to assess the effects of integrating Problem-Oriented Project-Based Learning (PO-PBL) into a STEM curriculum, emphasising enhancing students' 21st-century skills [11]. The research delineated in this article was analysed using a one-group quasi-experimental pre- and post-test approach.

1. Did the PO-PBL curriculum lead to statistically significant alterations in students' competencies for the 21st century?
2. Does the implementation of PO-PBL improve students' preparedness for the twenty-first century?

## 2. Literature Review

### 2.1 Web-based Project Management Software

PBL enables students to explore inquiries, formulate hypotheses and clarifications, engage in discourse on their concepts, contest the notions of others, and experiment with novel ideas [7]. To attain practical PBL implementations, the study delineated actions whereby students formulate and refine inquiries, deliberate ideas, strategise for issue resolution, collect information, derive conclusions, and convey results. In online PBL tasks, WebQuests, messages, blogs, forums, and social media sites are utilised to find information, exchange or modify ideas, and collaborate or cooperate [5]. A study said pupils can investigate, develop expertise, and formulate answers when the media facilitates online learning activities. The study revealed that PBL is successful when combined with peer-mentored learning, even with limited instructor support in a virtual classroom.

Another research used project-based learning in an online learning setting. The findings demonstrated that pupil participation in peer evaluation significantly influenced their project-based instruction. A study indicated that students had more varied behavioural patterns in an online project-based conversation activity, and respondents concentrated more on the discussion task. The investigation examined students' opinions of online project-based instruction in a flipped advertising course and determined that project deployments improved their learning, drive, enthusiasm, and collaboration.

### 2.2 Cloud Computing (CC) Within the Educational Sector

CC facilitates both solo and collaborative online work [14]. Several companies provide online learning environments using Creative Commons, such as educational packages or Google Apps for Schools. The study indicated that students collaboratively edit a document in real-time using CC.CC promotes relationships between learners and educators via adaptable learning situations and enhances communication and collaboration among learners. The investigation utilised Google Docs for cooperative writing assignments related to students' lab reports. An investigation was conducted using a Spreadsheet to analyse pupil conduct in a middle school. The research project utilised Spreadsheets and Forms in a test to gather and graph information from pupils by having them complete the forms.

## 3. Methods

Experiential education, or "learning by performing," is an efficient method for enhancing pupils' understanding of abstract concepts. A technique that facilitates such a strategy is Problem-Oriented Project-Based Learning (Po-PbL). Students participate in CC project work that prioritises artefact production, addressing real-world challenges derived from genuine and practical knowledge. The project's success depends on a collaborative effort between pupils and the instructor's guidance. The amalgamation of Po-PbL with STEM fields is an innovative strategy within the educational context.

The adopted curriculum integrates Po-PbL with STEM instruction, providing project-based and transdisciplinary activities that promote engaging and personalised student learning. The course's main aims include cultivating 21st-century skills, advanced cognitive processes, and academic competencies. To enhance involvement, the program included four unique module courses for the pupils: Energies, Urban Facilities, Transportation, and Mobile Communication, as seen in Fig. 1.

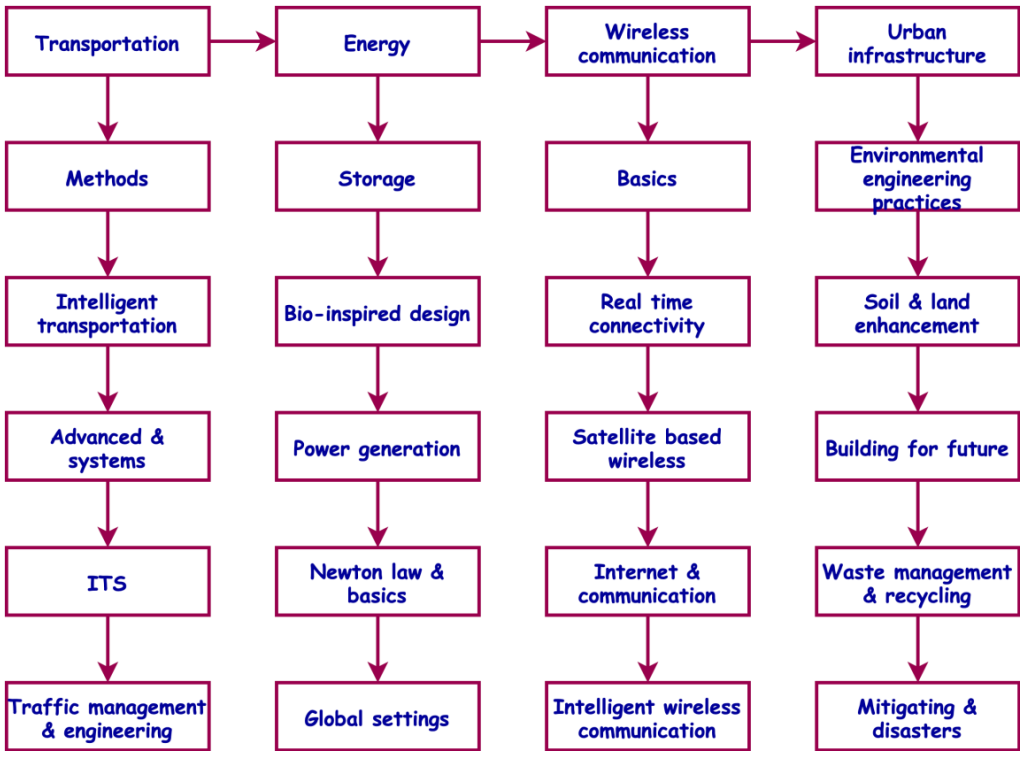


**Fig 1.** Proposed Integrated Cloud Storage in STEM Education

### 3.1. Demographics and Sampling Methodology

The research group included cognitively brilliant kids participating in an initiative in Uzbekistan. A total of 115 high school pupils from both public and private institutions took part in this study. These pupils had outstanding results on the Uzbekistan mathematics and science exams. They had participated in summer programs that offered STEM help, such as the Uzbekistan Initiatives.

### 3.2. Study Instruments

This research included two evaluative instruments: pupils' interest in STEM and 21st-century competencies. Both instruments used a Likert scale with five degrees of concordance (1=strongly = disapprove, 5=strongly = agree). The first instrument, aimed at gauging kids' interest in STEM, included a customised and adjusted survey for the Saudi setting. The survey had three categories: one's impression of an encouraging atmosphere for a STEM career (4 questions), interest in educational possibilities leading to a STEM profession (5 items), and the perceived value of a STEM career (3 items). The finalised version of the survey consisted of 12 items. The following instrument focused on evaluating 21st-century competencies. The survey was created by integrating ideas from pertinent previous research, including many aspects of 21st-century competencies. The abilities had five categories: technological literacy (7 things), inventive thinking (12 things), successful interaction (8 things), high efficiency (8 things), and religious beliefs (5 things). The final iteration of the survey consisted of 40 questions.

## 4. Result and Discussion

Professional judges, including distinguished faculty members from several Uzbekistan institutions, first evaluated the assessment instruments. The instructors had the title of professor and had expertise in mathematics instruction, assessment, and technology for education. The investigators got constructive criticism, remarks, and recommendations from the group, which were meticulously evaluated.

The phrasing of the questions was meticulously evaluated, and alternate choices were carefully considered. Crucial adjustments were made to the weights to ensure their precision and appropriateness. A pilot study was then undertaken to evaluate the reliability and accuracy of the evaluation tools using a sample of twenty pupils. To establish the construct accuracy of the measuring instrument, many metrics were examined, including Omega, Composite Dependability, and Macdonald's Beta. The research further assessed discriminant and convergent validity. The beta and Composite Reliability (CR) values for McDonald's range from 0.82 to 0.92 and 0.87 to 0.92, respectively. The figures exceed the recommended threshold (>0.6), indicating that the scales possess substantial internal consistency. The total Average Variance Extraction (AVE) values greater than the 50% necessary threshold span 0.69 to 0.82. The square root of the AVE, or discriminant accuracy parameters, must exceed the relationships among the latent parameters or components.

A comparison with the preceding column demonstrates that this requirement is met, since the loading component values exceed the stipulated minimum. These findings confirm the validity and dependability of the measures. Confirmatory Factor Analysis (CFA) was conducted using statistical programs such as Amos and SPSS to establish factor validity. CFA, a facet of Structural Equation Modelling (SEM), investigates the relationships among latent variables to identify deeper trends within the information being analysed. This statistical approach is crucial in several stages, including developing measuring tools, evaluating construct validity, and analysing technical implications. CFA is an essential phase in instrument development, as it validates the measurement tool's principal dimensions, load factors, and latent structure. CFA is an important analytical technique that significantly improves other aspects of psychometric assessment. The research sample received the final version of the survey to ensure multifactorial construct reliability. CFA was used to assess the conformity of the variables on the scale with their respective dimensions. Analysing the loading metrics for the scale elements on their corresponding levels was essential. It was concluded that items having a loading factor below 0.45 should not be allowed. The findings indicate that all items have loading factors over 0.45, meeting the specified condition.

## 5. Conclusion

The Uzbekistan sophisticated Program for Mathematics and Science improves 21$^{st}$-century skills by implementing Po-PbL. Numerous studies indicate that this pedagogical approach significantly improves five essential skills for the twenty-first century. The aspects include Digital Age Reading and writing, Creative Thinking, successful communication, Good Efficiency, and Religious Values.

The collaborative component of Po-PbL as an instructional technique notably enhances interpersonal abilities. The curriculum helps kids learn essential social skills and develop healthy attitudes by collaborating on CC projects. During project discussions, these need skilled people who can work together, bounce back from setbacks, and think outside the box. This way of teaching and thinking is significant in schools today because students need to be creative and active to solve problems in the 21st century.

It is essential to ensure that the ways we teach and learn are valid and up to date with what people want today. The Uzbekistan STEM is a good example of a modern, adaptable, and always-changing way to teach STEM subjects. This program helps build a creative and innovative human resources team to do essential tasks in the 21st century. It gives people the tools they need to plan and make wise choices in a world that is getting more globalised and fuller of information. The Uzbekistan STEM program, which uses the Po-PbL method, is essential for helping students learn the skills and information they need to do well in the 21st century. This curriculum allows colleges and universities to make people who are creative and think ahead, so they can handle the problems of a world that is changing quickly.

## References

[1] Chan, R. C. (2022). A social cognitive perspective on gender disparities in self-efficacy, interest, and aspirations in science, technology, engineering, and mathematics (STEM): The influence of cultural and gender norms. *International Journal of STEM Education, 9*(1), 1–13.

[2] Shiraishi, Y., Mohri, M., &Fukuta, Y. (2011). A server-aided computation protocol revisited for confidentiality of cloud service. *Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, 2*(2), 83–94.

[3] Wan, Z. H., So, W. M. W., & Zhan, Y. (2022). Developing and validating a scale of STEM project-based learning experience. *Research in Science Education, 52*(2), 599–615.

[4] Khodjaev, N., Boymuradov, S., Jalolova, S., Zhaparkulov, A., Dostova, S., Muhammadiyev, F., Abdullayeva, C., &Zokirov, K. (2024). Assessing the effectiveness of aquatic education program in promoting environmental awareness among school children. *International Journal of Aquatic Research and Environmental Studies, 4*(S1), 33–38. https://doi.org/10.70102/IJARES/V4S1/6

[5] Ramatov, J. S., Baratov, R. U., Umarova, R. S., Sultanov, S. X., &Jumaniyozova, N. S. (2025). Transport and transit policy in Uzbekistan: A guarantee of sustainable economic growth. In *Management of Digital Technologies in the Innovative Economy* (pp. 269–274). Springer, Cham.

[6] Kavitha, M. (2023). Beamforming techniques for optimizing massive MIMO and spatial multiplexing. National Journal of RF Engineering and Wireless Communication, 1(1), 30-38. https://doi.org/10.31838/RFMW/01.01.04

[7] Choudhary, S., & Reddy, P. (2025). Improving the storage duration and improving the characteristics of tender coconut water using non-thermal two-phase microfiltration. *Engineering Perspectives in Filtration and Separation, 3*(1), 7–12.

[8] Saleh, A., Phillips, T. M., Hmelo-Silver, C. E., Glazewski, K. D., Mott, B. W., & Lester, J. C. (2022). A learning analytics approach towards understanding collaborative inquiry in a problem-based learning environment. *British Journal of Educational Technology, 53*(5), 1321–1342.

[9] Mitra, A., & Shah, K. (2024). Bridging the digital divide: Affordable connectivity for quality education in rural communities. *International Journal of SDG's Prospects and Breakthroughs, 2*(1), 10–12.

[10] Douglas, D., Salzman, H., &Khudododov, K. (2025). Mismeasuring STEM?: Assessing STEM course taking among US bachelor's degree graduates. *Journal for STEM Education Research*, 1–25. https://doi.org/10.1007/s41979-025-00154-1.

[11] Aravind, B., Harikrishnan, S., Santhosh, G., Vijay, J. E., & Saran Suaji, T. (2023). An efficient privacy-aware authentication framework for mobile cloud computing. *International Academic Journal of Innovative Research, 10*(1), 1–7. https://doi.org/10.9756/IAJIR/V10I1/IAJIR1001

[12] Roper, S., & Bar, P. (2024). Secure computing protocols without revealing the inputs to each of the various participants. International Journal of Communication and Computer Technologies, 12(2), 31-39. https://doi.org/10.31838/IJCCTS/12.02.04

[13] Chen, J., Kolmos, A., & Du, X. (2021). Forms of implementation and challenges of PBL in engineering education: A literature review. *European Journal of Engineering Education, 46*(1), 90–115.

[14] Vishaka, S., & Selvi, S. (2017). An analysis of various security issues and recent techniques in multi-cloud computing environment. *International Journal of Advances in Engineering and Emerging Technology, 8*(4), 1–9.

[15] Al-Thani, N. J., & Ahmad, Z. (2025). The scope of problem-based learning and integrated research education for primary learners. In *Teaching and Learning with Research Cognitive Theory* (pp. 25–43). Springer, Cham.

[16] Sharma, M., Singh, A., & Daim, T. (2023). Exploring cloud computing adoption: COVID era in academic institutions. *Technological Forecasting and Social Change, 193*, 122613.

[17] Nazarova, S., Abdullayeva, M., Karimova, D., Turgunova, M., & Sharipova, N. (2024). The role of online libraries in advancing the study of Uzbek culture. Indian Journal of Information Sources and Services, 14(3), 207–215.

[18] Loku, A., & Loku, N. (2025). Globalization, Automation, and the Future of Work: Examining the Impact of Technological Advancements on the Workforce. Quality-Access to Success, 26(4).

[19] Arun Prasath, C. (2025). Performance analysis of induction motor drives under nonlinear load conditions. National Journal of Electrical Electronics and Automation Technologies, 1(1), 48–54.

[20] Han, S. I., & Son, H. (2025). Evaluating What Matters: Student Perspectives On Peer Evaluation In Cooperative Learning. International Online Journal of Education & Teaching, 12(1).