Asian Journal of Research in Education and Social Sciences
e-ISSN: 2682-8502 | Vol. 7, No. 2, 304-311, 2025
https://asianscholarsnetwork.com/asnet-journals
SPECIAL ISSUE: International Conference on Future and Sustainable Education (ICFSE) 2024

Polytrans: Polypeptide Synthesis Learning Kit

Noorhusaini Osman[1*], Mohd Shahir Mohamed Sunar[2], Hafizi Yazid[2]

[1] MARA College Foundation Programme, Science Department, Kolej MARA Kuala Nerang, Malaysia
[2] MARA College Foundation Programme, Kolej MARA Kuala Nerang, Malaysia

*Corresponding Author: noorhusaini.osman@mara.gov.my

Received: 15 July 2024 | Accepted: 1 December 2024 | Published: 1 March 2025

DOI: https://doi.org/10.55057/ajress.2025.7.2.29

Abstract: *Understanding scientific concepts such as atoms, molecules, cells, and biochemical processes can be challenging due to their abstract nature. Proteins, which provide structural and functional roles in skin, hair, muscles, hormones, enzymes, and various body parts, represent these challenges. Fundamental learning of the central dogma of protein synthesis (transcription and translation) is particularly difficult because proteins are small, invisible, and complex molecules. In addressing this issue, PolyTrans learning kit assists in transform the conceptual understanding of transcription and translation into a tangible, visual, and hands-on activity. The PolyTrans Kit is an affordable, attractive, mobile, user-friendly, and replicable educational tool. It includes colourful components of protein synthesis, secured by magnetic and strap fasteners. Additionally, an interactive Augmented Reality (AR) feature allows students to visualize and engage with an invisible process, enhancing their overall learning experience. This kit aims to provide an effective, enjoyable, and engaging experience for students, enhancing their interaction with the subject matter. By doing so, it fosters a deeper and more permanent understanding through dynamic participation. The effectiveness of the PolyTrans Kit was evaluated using a quasi-experimental design. Students were divided into two groups: one using conventional teaching methods and the other using the PolyTrans Kit. Levene's test confirmed the assumption of homogeneity of variance between the groups. The Independent Sample t-Test results indicated a statistically significant difference in biology test scores between the groups ($t(33) = -3.18$, $p < 0.05$). Specifically, the mean score of students using the PolyTrans Kit (mean = 84.5) was higher than that of students taught with conventional methods (mean = 76.8). In summary, the significant difference scores between the groups of students indicate PolyTrans shows an efficacy in fostering students understanding in protein synthesis learning*

Keywords: Protein Synthesis, Learning Tools, Pre-university

1. Introduction

Scientific concepts are often very abstract and difficult to understand as in a form of atom, molecule, cell and biochemical processes. Fundamental on central dogmatic of protein synthesis (transcription and translation) are challenging process as proteins are particularly small, not visible and complex molecule (Guzman & Bartlett, 2012). It is often to be poorly understood which always led to students' misconception, (Fisher, 1985; Guzman & Bartlett, 2012). The difficulties often challenge of mastering specialized terminology and concepts. Traditional teaching methods may not fully address these issues too, resulting in gaps in students' knowledge and comprehension. Traditional instructional methods, which rely heavily

on theoretical lectures and passive learning, may fail to adequately engage students and provide them with practical, hands-on experiences essential for understanding biochemical principles. As a result, there is a pressing need for innovative educational tools that can bridge the gap between theoretical knowledge and practical application in polypeptide synthesis education. Moreover, the COVID-19 pandemic has worsened these challenges by disrupting traditional classroom settings and demanding the adoption of remote and blended learning approaches. This gap highlights the necessity for innovative educational tools that can enhance students' understanding and retention of complicated biological processes. Theoretically, protein synthesis process is able to be explained through alternative resources, however, it is still difficult to be imagined as it is untouchable at micro level. Thus, PolyTrans, a comprehensive tool, offers a solution in helping students to overcome learning obstacles and improve the gap of complex processes in protein synthesis. This research aims to explore the effectiveness of PolyTrans in measuring students' understanding on protein synthesis. PolyTrans learning kit is reinforced with an interactive Augmented Reality (AR) to enable the visualization of transcription and translation process into a real interactive and hands-on activity to be more effective, meaningful, focus and tangible ways of learning (Davenport et al., 2017; Nurul' ain Fitri et al., 2022). Thus, addressing these challenges the development of PolyTrans: Polypeptide Synthesis Learning Kits, offers student an experiential learning opportunity in biology and biochemistry with a better understanding and proficiency in polypeptide synthesis learning concepts. Therefore, to address this gap, the research objectives are to:

i. Develop PolyTrans: Polypeptide Synthesis Learning Kit.
ii. Conduct a study to measure the efficacy of PolyTrans Learning Kit in fostering students understanding in protein synthesis learning process.

Theories and Frameworks to Complement the Quasi-Experimental Design

This research framework integrates the constructivist learning theory, the ADDIE model, and the quasi-experimental design systematically to investigate the impact of PolyTrans on student learning in protein synthesis topic. A development of a plan to integrate PolyTrans into teaching and learning is designed for a specific learning activities, assessments and action research study base on quasi-experimental design, on the selection of control and experimental groups. A formative evaluation throughout the implementation phase shall be conducted to evaluate the summative evaluations using pre-test and post-test data to measure learning outcomes. The data gain shall be tabulated to compare the performance of the control and experimental groups for reflection on the findings and for making a necessary adjustment.

A quasi-experiment is a research design rather than a theory or framework. It is used to evaluate the impact of an intervention by involving selecting groups, upon which a variable is tested. In this study, a quasi-experimental design is based on nonequivalent groups (Campbell & Stanley, 1996) and does not involve random selection of respondents (Fraenkel & Wallen, 2008; Lim, 2007) is to assess the efficacy of PolyTrans in teaching protein synthesis involving two groups of students: one group using traditional teaching methods (control group) and another group using PolyTrans as a supplementary tool (experimental group). Pre-tests and post-tests will be administered to both groups to measure their understanding of protein synthesis before and after the intervention. This design is also frequently used in studies examining the effectiveness of a teaching method, module, or program in various situations where true experimental design cannot be used, especially in real-world settings in colleges or schools (Asmah, 2008; Chua, 2006; Gribbons & Herman, 1997; Mok, 2009; Newman, 1991).

Constructivist learning theory suggests that learners actively construct their own understanding and knowledge through experiences and reflections (Harasim, 2018). This theory emphasizes

the importance of engaging students in activities that require them to interact with content, solve problems, and apply what they have learned in meaningful contexts. In the context of protein synthesis, constructivist approaches can involve simulations, interactive tools, and collaborative projects that allow students to explore and understand the process in a hands-on manner. PolyTrans is a tool that supports active learning and helps students construct their knowledge by providing real-time enhancing comprehension of protein synthesis during the learning process (Powell & Kalina, 2009).

ADDIE Model provides a systematic approach to instructional design and ensures that each phase of the process is thoroughly addressed. The ADDIE Model, known for its flexibility, allows teachers to adapt to the varying needs of their students. Additionally, it is highly suitable for incorporating technology, which is considered a crucial aspect of modern education (Gayosso Mexia et al., 2017). The ADDIE model (Analyze → Design → Develop → Implement → Evaluate) is a widely-used instructional design approach for creating effective learning experiences. Historically, numerous learning activities have been developed using the ADDIE framework model (Lee et al., 2024). ADDIE instructional design framework guides the process of creating effective educational framework for this research by systematically integrate PolyTrans into teaching and learning process, from analyzing the needs to evaluating the outcomes.

2. Methodology

Participants and Setting

This study utilized a quasi-experimental non-equivalent groups design to evaluate the effectiveness of the PolyTrans Learning Kit on students' understanding of polypeptide synthesis which is a part of the pre-university Biology subject. Given the constraints of educational settings where random assignment is often impractical, this design was deemed suitable to assess the impact of an educational intervention in a controlled environment. The research was conducted with a total of 64 pre-university students enrolled in a biology course at a MARA College in Malaysia. These students were purposively divided into two groups: a control group (n = 33), which followed the conventional lecture-based approach, and an experimental group (n = 31), which was exposed to the PolyTrans Learning Kit. The selection was based on existing class groupings to maintain the natural educational context and minimize disruption to regular academic schedules.

Research Design and Procedure

The study was structured into three distinct phases to systematically assess the impact of the intervention:

i. Pre-Test (T1) Administration:

Prior to the intervention, both the control and treatment groups underwent a pre-test to gauge their baseline understanding of protein synthesis, specifically focusing on the processes of transcription and translation. The test is using a set of standardized test questions designed to evaluate students' foundational knowledge and conceptual grasp of the topic.

ii. Intervention with PolyTrans Learning Kit (X1):

The experimental group participated in a one-week instructional session utilizing the PolyTrans Kit. This kit comprises physical models, colorful magnetic components, and an integrated Augmented Reality (AR) feature to facilitate the visualization of molecular processes. Students in this group engaged in hands-on activities, group discussions, and AR simulations to explore the mechanisms of transcription and translation.

In contrast, the control group continued their learning through traditional methods, which primarily involved lectures, textbook readings, and instructor-led explanations without any interactive tools or supplementary aids.

iii. Post-Test (T2) Evaluation:

After the one-week intervention, both groups were administered a post-test identical to the pre-test to assess any changes in their comprehension levels. The objective was to measure the extent to which the PolyTrans Kit influenced students' learning outcomes compared to conventional teaching approaches.

Data Collection and Analysis

Quantitative data were collected through pre-test and post-test scores and analysed using IBM SPSS Statistics Version 27. The statistical analysis comprised:

- Descriptive statistics to compare mean scores before and after the intervention within each group.
- Inferential statistics through an Independent Sample t-Test to determine whether the observed differences between the groups were statistically significant.
- The Shapiro-Wilk test was employed to check for normality in the distribution of the test scores, while visual assessments such as Q-Q plots and boxplots confirmed that the data adhered to the assumptions required for parametric testing.

Additionally, qualitative data were gathered through focus group interviews conducted with a subset of students from the treatment group. A total of 12 students participated in semi-structured interviews to provide deeper insights into their experiences using the PolyTrans Kit. Thematic analysis was applied to the interview transcripts to identify key themes related to student engagement and conceptual understanding. The feedback from the focus group interviews underwent a six-stage analysis process (Braun & Clarke, 2006), which included recording the respondents' conversations, transcribing verbatim, familiarizing, coding, storing, and converting to themes.

3. Results and Discussions

The findings from both the quantitative and qualitative analyses are discussed in detail below, with a focus on interpreting the implications for educational practice.

i. Quantitative Analysis: Improvement in Learning Outcomes.

The quantitative results revealed a clear and statistically significant improvement in the comprehension levels of students who used the PolyTrans Kit compared to those who followed conventional instructional methods.

Descriptive Analysis

Table 2: Mean Pre-Test and Post-Test Scores for Control and Treatment Groups.

Control Group			Treatment Group		
Mean Test Score (%)		Changes	Mean Test Score (%)		Changes
Pre	Post		Pre	Post	
72	77	+5	70	85	+15

Through descriptive statistical analysis, it was found that the treatment group's mean achievement increases of 15% was higher than the control group's increase of 5%. However, these findings cannot be accepted and confirmed solely by referring to descriptive statistical

analysis (Mohd Yusri, 2010). Therefore, inferential statistical analysis (independent samples t-test) was used to confirm whether there was a significant difference in the increase in achievement levels between students in the treatment group and those in the control group. This study employed an independent samples t-test to answer the research question.

The Independent Sample t-Test results indicated a significant difference between the two groups' post-test scores ($t(62) = 3.180$, $p = 0.002$). The treatment group's mean score was notably higher ($M = 84.50$, $SD = 8.14$) compared to the control group's ($M = 76.75$, $SD = 11.01$). This indicates that the PolyTrans Kit had a substantial effect on students' understanding of polypeptide synthesis.

ii. Qualitative Analysis: Insights from Student Feedback

To complement the quantitative findings, focus group interviews were conducted to explore the experiences of students who used the PolyTrans Kit.

Theme 1: Facilitating the Learning Process

The first theme regarding the use of the Polytrans teaching aid in learning the topic of polypeptide synthesis is that it has facilitated their learning process. The majority of students (n=10) stated that using Polytrans greatly helped them understand abstract biological concepts like the topic of polypeptide synthesis. This is evident from the following student statements:

Focus Group 1: "*In my opinion, Polytrans is a learning tool that can help and facilitate my understanding of the topic of protein synthesis, as it is quite difficult to understand just by reading without physical description*."

Focus Group 2: "*Protein synthesis is hard to visualize because the process occurs inside our bodies. So, with Polytrans, it helps me to visualize the process. Therefore, I can understand how the synthesis process occurs better*."

When students begin to understand what they have learned, it will further generate interest for them to continue learning and delve deeper into the topic. This situation is clearly understood through a statement from a student in Focus Group 1:

Focus Group 1: "*To be frank, biology has always been my greatest nemesis, especially when it comes to memorizing facts and understanding complex processes like the Kreb's Cycle and protein synthesis. I find it so strenuous to fully understand and grasp the concept of protein synthesis due to my inability to clearly visualize the whole process in my mind. However, things have completely changed with the creation of the learning aid kit. With the help of the learning aid kit, I am now able to easily visualize the mechanism of protein synthesis without any problem. The fact that it is so colourful and interactive makes it a really fun activity to do in class*!"

This finding is consistent with several previous studies, which have found that students become more focused and enthusiastic about learning when learning activities involve teaching aids (Chin & Noh, 2016; Musa & Mohamad, 2015). Furthermore, this study's findings are consistent with Musa and Mohamad (2014) in terms of increasing students' motivation to learn and academic achievement through the effectiveness of teaching aids during teaching and learning sessions.

Theme 2: Increased Engagement and Collaboration:
The kit also promoted active participation and collaborative learning among students. The hands-on activities required group interaction, which fostered teamwork and communication skills. One student mentioned, "*Working with my peers using the kit made the lesson more enjoyable and helped me understand the concepts better through discussion*".

Students highlighted that the interactive nature of the kit transformed the learning experience from a passive reception of information to an active and engaging process, thus reducing boredom and increasing motivation.

Besides facilitating the learning process, most students also believe that the learning process with Polytrans has made their learning more active and involved two-way discussions (n=8). For example, a student in Focus Group 2 stated, "*Students always ask and discuss among group members during the learning process to complete tasks given using the help of Polytrans*."

A student from Focus Group 1 also stated, "*The use of Polytrans not only facilitates the teacher, but students also experience a more active and lively learning session. This situation creates a learning system that is different from others*." This statement was shared by another student from Focus Group 2 who said, "*this learning method has made us always active. Unlike previous learning methods which were usually in lecture form and quite passive, making me feel sleepy. But now, with Polytrans, we need to be active*."

This finding supports several previous studies. For instance, a study by Nugrahani (2020) also found that using teaching aids positively influences students' engagement and performance. Similarly, the study by Nik Zarini and Salmiza (2012) also found that students actively participated in teaching and learning activities, with two-way interaction and sharing learning experiences with peers, which increased their self-confidence.

4. Conclusion

PolyTrans Learning Kit demonstrates a potential learning tool for protein synthesis process. Thus, this study provides a valuable insight as the tool contributes a positive efficacy in fostering students understanding in protein synthesis learning process base on the significant difference scores between the groups data in quasi-experimental design.

Acknowledgments
The authors acknowledge Department of Science, Asasi Kolej MARA, Kolej MARA Kuala Nerang, Malaysia and Majlis Amanah Rakyat. Special thanks to those who contributed to this project directly or indirectly.

References

Asmah Haji Omar. (2008). Kaedah penyelidikan bahasa di lapangan (2nd ed.). Kuala Lumpur: Dewan Bahasa dan Pustaka.
Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3:* 77-101.
Campbell, D. T., & Stanley, J. G. (1996). Experimental and quasi experimental design for research. Chicago: Rand Mc Nally College Publishing Company.

Chin, K. H., & Noh, N. M. (2016). The Effectiveness Of The Use Of Interactive Whiteboard In Malay Language Learning Among Year 3 Students (11-17). *Jurnal Pendidikan Bitara UPSI*, *9*(2), 11-17.

Chua Yan Piaw. (2006). Kaedah statistik penyelidikan. Buku Satu: Kaedah penyelidikan. Kuala Lumpur: McGraw Hill.

Creswell, J. W. (2008). Educational research: planning, conducting, and evaluating quantitative and qualititave research. Upper Saddle River, NJ: Pearson / Merrill Education.

Davenport, J., Pique, M., Getzoff, E., Huntoon, J., Gardner, A., & Olson, A. (2017). A Self-Assisting Protein Folding Model for Teaching Structural Molecular Biology. *Structure*, *25*(4), 671–678. https://doi.org/10.1016/j.str.2017.03.001

Fisher, K. M. (1985). A misconception in biology: Amino acids and translation. *Journal of Research in Science Teaching*, *22*(1), 53–62. https://doi.org/10.1002/tea.3660220105

Fraenkel, J. R., & Wallen, N. E. (2008). How to design and evaluate research in education (7th ed.). Avenue of the Americas, NY: McGraw-Hill Higher Education.

Gay, L. R., Mills, G. E., & Airasian, P. (2009). Educational research: Competencies for analysis and applications. Upper Saddle Ridge, NJ: Pearson.

Gayosso Mexia, S., Alfaro Ponce, M., & Franco Campos, R. (2017). Instructional Design by employing the ADDIE Model to enhance the performance of undergraduate students. *Boletín Científico INVESTIGIUM de La Escuela Superior de Tizayuca*, *3*(5), 1–6. https://doi.org/10.29057/est.v3i5.2425

Gribbons, B. & Herman, J. (1997). True and quasi-experimental designs. Practical Assessment, Research & Evaluation, 5(14). Retrieved from http://PAREonline.net/getvn.asp?v=5&n=14.

Guzman, K., & Bartlett, J. (2012). Using simple manipulatives to improve student comprehension of a complex biological process: Protein synthesis. *Biochemistry and Molecular Biology Education*, *40*(5), 320–327. https://doi.org/10.1002/bmb.20638

Harasim, L. (2018). Constructivist Learning Theory. *Learning Theory and Online Technologies*, *October*, 61–79. https://doi.org/10.4324/9781315716831-5

Jackson, S. (2014). Research methods: a modular approach. Cengage Learning.

Krueger, R. A., & Casey, M. A. (2000). *Focus groups: A practical guide for applied research* (3rd. ed.). Thousand Oaks, CA: Sage.

Lee, K. Y. R., Ng, Y. N. B., & Chen, M. D. (2024). Adoption of the ADDIE Approach in an Agile Way for the Development of Biochemistry Courseware for Learning Metabolism. *Journal of Chemical Education*, *101*(3), 1292–1301. https://doi.org/10.1021/acs.jchemed.3c00851

Lim Chong Hin. (2007). Penyelidikan pendidikan: Penyelidikan kuantitatif dan kualitatif. Kuala Lumpur: McGraw Hill.

Mohd Yusri Ibrahim. (2010). Bimbingan cepat analisis data penyelidikan untuk pendidikan dan sains sosial. Kuantan, Pahang: Bandar Ilmu.

Mok Soon Sang. (2009). Literatur dan kaedah penyelidikan. Puchong, Selangor: Penerbitan Multimedia

Mugambi, M. M. (2018). Linking Constructivism Theory to classroom practice. *International Journal of Humanities, Social Sciences and Education*, *5*(9), 96–104. https://doi.org/10.20431/2349-0381.0509014

Musa, F., & Mohamed, M. (2015). Incorporating Computer-Mediated communication in project work. *International Education Studies*, *8*(5), 150-157.

Newman, W. L. (1991). Social research methods: Qualitative and quantitative approaches. Boston, MA: Allyn and Bacon.

Nik Zarini and Saleh, Salmiza. (2012). Kesan pendekatan inkuiri penemuan terhadap pencapaian pelajar dalam mata pelajaran kimia (The effect of inquiry discovery

approach towards student achievement in the subject of Chemistry. The Asia Pacific Journal of Educators and Education *27* (1). pp. 1-16. ISSN 2289-9057

Nugrahani, R (2020). Media pembelajaran berbasis visual berbentuk permainan ular tangga untuk meningkatkan kualitas belajar mengajar di sekolah dasar. Lembaran Ilmu Kependidikan, journal.unnes.ac.id, https://journal.unnes.ac.id/nju/index.php/LIK/article/view/524

Nurul' ain Fitri, N., Azim, A., Isa, M., Yahya, H., Zhafri Bin, M., & Nazmi, M. (2022). AR-Learn Model: Augmented Reality (AR)-Based Learning Application Development Model. *The Sultan Alauddin Sulaiman Shah Journal (JSASS)*, *9*(1), 31–43.

Powell, K. C., & Kalina, C. J. (2009). Cognitive and social developing tools for an effective classrooom. *Education*, *130*(2), 241–250.

Wiersma, W., & Jurs, S. G. (2009). Research method in education: An introduction (9th ed.). Boston, MA: Allyn and Bacon.