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ABO Blood Group and Rhesus Profiling Software as a Learning Tool

Evana Kamarudin*, Mohd Fahmi Mastuki, Wan Shahriman Yushdie Wan Yusoff, Mohd Nazri Abu

**Corresponding Author*

Centre for Medical Laboratory Technology, Faculty of Health Sciences, Universiti Teknologi MARA, Campus Puncak Alam, 42300 Puncak Alam, Selangor, Malaysia

evana@uitm.edu.my, mohdfahmi@uitm.edu.my , wshahriman@uitm.edu.my , nazri669@uitm.edu.my
Tel: +601110103674

Abstract

The study examined the ABO and Rh Profiling (ARGOS) software's impact on learning Fundamental of Transfusion Practice at UiTM. ARGOS, a new software, complements traditional blood typing. The survey questionnaires were employed to evaluate the effect of the use of the ARGOS in students' learning. ARGOS minimized errors and facilitated ABO grouping accurately. It simplified Rh system understanding, including Fisher-Race, Weiner, Rosenfield, and Tippet's nomenclature. ARGOS enhanced student engagement, offering immediate feedback, and verifying comprehension. Overall, the software improved learning outcomes by aiding in result accuracy, reducing errors, and simplifying complex concepts, fostering a deeper understanding of the subject matter.

Keywords: ABO, Rhesus profiling,software,

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1.0 Introduction

ABO and Rh blood grouping are fundamental procedures in transfusion medicine, aimed at preventing adverse reactions during blood transfusions. The ABO system classifies blood into four major groups: A, B, AB, and O, based on the presence or absence of antigens on red blood cells (Daniels et al., 2009). Similarly, the Rh system categorizes blood into Rh-positive or Rh-negative based on the presence or absence of the Rh antigen. The accurate determination of ABO and Rh blood groups through forward and reverse grouping is crucial before transfusion to ensure compatibility between donor and recipient blood. According to the International Society for Blood Transfusion, with 55 antigens, the Rh blood group system is the most polymorphic among the other blood group system (Daniels et al., 2009). ABO and Rh are recognized as the most clinically significant due to the severity of their adverse effects and their essential application in blood grouping. Despite the importance of accurate blood grouping, multi-transfused patients are at risk of alloantibody generation due to repeated exposure to foreign antigens from transfused blood components (Zhao et al., 2023). Alloantibodies,

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generated through alloimmune responses, can lead to hemolytic transfusion reactions and complications in subsequent transfusions. Therefore, stringent monitoring and management of alloimmunization in multi-transfused patients are crucial to minimize the risks associated with alloantibody formation.

This occurrence has been the cause of various adverse reactions, with the occurrence as high as 2.21% in 2021. This high rate is due to the numerous Rh systems such as Fisher-Race, Weiner, Rosenfeld and Tippet's, all of which can cause adverse reaction if incompatible blood. This is especially evident in Malaysia that consists of many ethnic groups and each ethnic groups has their own different distribution of red cell phenotypes (Musa et al., 2012). In addition, although the procedures for ABO grouping are relatively simple, ABO blood groping discrepancies still occurs with a frequency up to less than 0.1% (Shahshahan and Hayati, 2020). Clerical errors are common and are responsible for one third of transfusion related deaths (Nepal et al., 2019). While the frequency is fortunately low, it still pose a problem as the resulting transfusion reactions might be as severe as death. Problems arise when students face difficulties in identifying the various nomenclature in Rh systems in the patients' blood for Rh phenotyping. Hence, the need for competent students in blood grouping remains high.

1.1 Digital technologies

To foster this competence, digital technologies have been explored by educational institutions to enhance the learning experience for students. Hrtoňová et al. (2015) stated that digital technologies are permeating all aspects of life, including learning and educational growth. Students of all ages are becoming more familiar with digital technologies yet understanding these rapid technological changes becomes a challenge to educators due to the low technology competence and their lack of desire to change the existing teaching framework (Zeehan et al., 2020). In sooth, the most recent technologies must be incorporated into higher education as the development of digital technology presents a chance for teaching enhancement due to the digital resources' penetration in recent times. A survey by Singh et al. (2021) revealed that students are mostly like unsupportive of digital learning due to the inadequate information and communication infrastructure. Similarly, the survey by Sarker et al. (2019) stated that e-learning are well-accepted by most student, however there are constraints that includes poorly designed learning materials that do not allow much interaction. Thus, digital innovations must be done to explore the endless possibilities of digital technologies in enhancing learning experience and foster competency.

1.2 ARGOS

Innovations in educational technology have transformed traditional learning paradigms, offering new avenues for interactive and personalized learning experiences. One such innovation is the ABO and Rh Profiling (ARGOS) software, which holds promise as a valuable tool in teaching blood grouping concepts. This section elaborates on the advantages of interactive software in education, the potential of ARGOS as a learning tool, and its integration into healthcare settings to ensure safer blood transfusions. Interactive software platforms revolutionize traditional teaching methods by providing engaging and immersive learning experiences. These platforms enable students to actively participate in the learning process through simulations, virtual experiments, and multimedia presentations. Research has shown that such interactive experiences promote higher levels of student engagement and motivation, leading to improved learning outcomes (Mayer, 2019). ABO and Rh Profiling (ARGOS) software represents a significant advancement in blood grouping education, offering interactive and tailored content to meet individual learning needs. ARGOS provides students with opportunities to explore blood grouping concepts through interactive modules, virtual laboratories, and multimedia resources. By engaging students actively in the learning process, ARGOS enhances comprehension and retention of complex topics. Moreover, ARGOS generates data on student performance and areas of difficulty, enabling educators to make data-driven decisions to support student learning effectively.

In addition to its educational applications, ARGOS has the potential to be integrated into laboratory information systems (LIS) utilized by healthcare settings. By incorporating ARGOS into LIS, healthcare professionals can streamline blood typing processes, minimize human error, and ensure safer blood transfusions. ARGOS provides a standardized platform for blood typing procedures, allowing healthcare professionals to access accurate and up-to-date information on donor and patient blood types. This integration enhances efficiency, reduces the risk of transfusion errors, and ultimately improves patient safety in healthcare settings.

ABO and Rh blood grouping are essential procedures in transfusion medicine to ensure safe blood transfusions. The ABO system classifies blood into four groups (A, B, AB, and O), while the Rh system categorizes blood as Rh-positive or Rh-negative. Accurate blood typing is crucial to prevent adverse reactions during transfusions.However, learning these systems can be challenging, especially the complex Rh system with its many antigens. Traditional teaching methods often lead to errors and make it hard for students to understand and accurately perform blood typing.

The new ABO and Rh Profiling (ARGOS) software is designed to help overcome these challenges by providing accurate results, simplifying the Rh system concepts, and engaging students more effectively. This study aims to evaluate how well the ARGOS software improves students' understanding, reduces errors, and enhances learning in the Fundamentals of Transfusion
Practice at UiTM which is the core subject for Medical Laboratory Technology Programmed.

2.0 Methodology

2.1 Experimental Design

To determine the effectiveness of ARGOS software as a teaching tool, a quasi-experimental study design was conducted on a sample of 78 students enrolled in Medical Laboratory Technology in UiTM Puncak Alam. The control group course received a traditional teaching

methodology (N=38) while ARGOS was implemented to the experimental group (N=48). All students took identical exams focused on blood grouping and Rh phenotyping. All registered MLT students that required to take the subjects were selected.

2.2 Data Collection

Online self-administered survey questionnaires testing evaluating the participants' overall experience using the ARGOS software were administered to the group of students that used the ARGOS software (N=48) after the examination was conducted.

The survey was done using Google Form and was made available to the participants from week 3 to week 5 after they make use of the ARGOS software for that semester. The online survey tool was a 14-item survey that incorporated a 5-point Likert scale, with (1) being strongly agree and (5) being strongly disagree. This tool's design was divided into three parts, (1) the satisfaction of participants after using the ARGOS software, (2) the attitude of participants on the ARGOS software and (3) the overall experience of participants on using ARGOS software.

The ARGOS software is a software that upon registering the patients' details and blood grouping result using the forward and reverse method, the possible genotype was automatically generated. The software also include visual references for agglutination patterns using tile method, tube method and gel card method to further heighten the confidence of user when grading the agglutination score.

2.3 Data Analysis

The statistical difference of exam scores between the students who used ARGOS software and the students who did not use the ARGOS software were calculated with Independent t-test using Statistical Package for the Social Sciences (SPSS) programme IBM. $P < 0.05$ was set as the significance value. Tabulation of data from the questionnaire survey was done using Excel and graphs of the data was generated.

2.4 Ethical

No ethical approval involved in this study and the type of this survey is confidential.

3.0 Findings

3.1 Student Exams Scores

Table 1. Comparison in the exam scores between students who used ARGOS software versus students who did not use the ARGOS software

	Students who used ARGOS software (N=48)	Students who did not use ARGOS software (N=38)	*P*
Exam scores	18.1 ± 2.8	15.7 ± 2.5	< 0.01

The exam scores were expressed as mean ± standard deviation. P value was set to < 0.05.

Table 1 provides a comprehensive comparison of exam scores between students who utilized the ARGOS software and those who did not. The data analysis reveals a notable difference in mean scores between the experimental group, which utilized ARGOS, and the control group, which did not. Specifically, the experimental group exhibits a significantly higher mean score compared to the control group, indicating a positive impact of utilizing ARGOS on students' exam performance. This observed difference in mean scores between the two groups is statistically significant, underscoring the effectiveness of ARGOS in improving students' exam scores related to blood grouping. These findings suggest that the interactive and tailored learning experiences facilitated by ARGOS contribute to enhanced comprehension and retention of course material, ultimately translating into improved academic performance among students. Overall, the results of this analysis support the conclusion that ARGOS serves as an effective tool for enhancing students' understanding and proficiency in blood grouping concepts, as evidenced by the significant difference in exam scores between the experimental and control groups.

3.2 Student Satisfaction

The feedback gathered from the participants offers valuable insights into their satisfaction and experience with the ARGOS software system. Among the 48 participants, a notable proportion, representing 29% of the total, expressed strong agreement with statements indicating efficiency, speed, and effectiveness in completing their work using the system. Specifically, these participants found the ARGOS software to be conducive to efficient task completion, highlighting its usability and functionality. Furthermore, the item "It was simple to use this ABO Rh software system" garnered the highest number of strong agreements, with 33% of participants endorsing its ease of use. This indicates that a significant portion of users found the ARGOS software to be intuitive and user-friendly, facilitating a seamless learning experience. Notably, the absence of strong disagreements among participants underscores the overall high satisfaction levels with the ARGOS software. The majority of participants either agreed or strongly agreed with all items, comprising between 37% and 50% of the total respondents. This widespread agreement suggests a consensus among users regarding the effectiveness, ease of use, and overall satisfaction with the ARGOS software. These findings reinforce the positive impact of ARGOS in facilitating learning and enhancing user experience, further validating its potential as a valuable tool in educational settings.

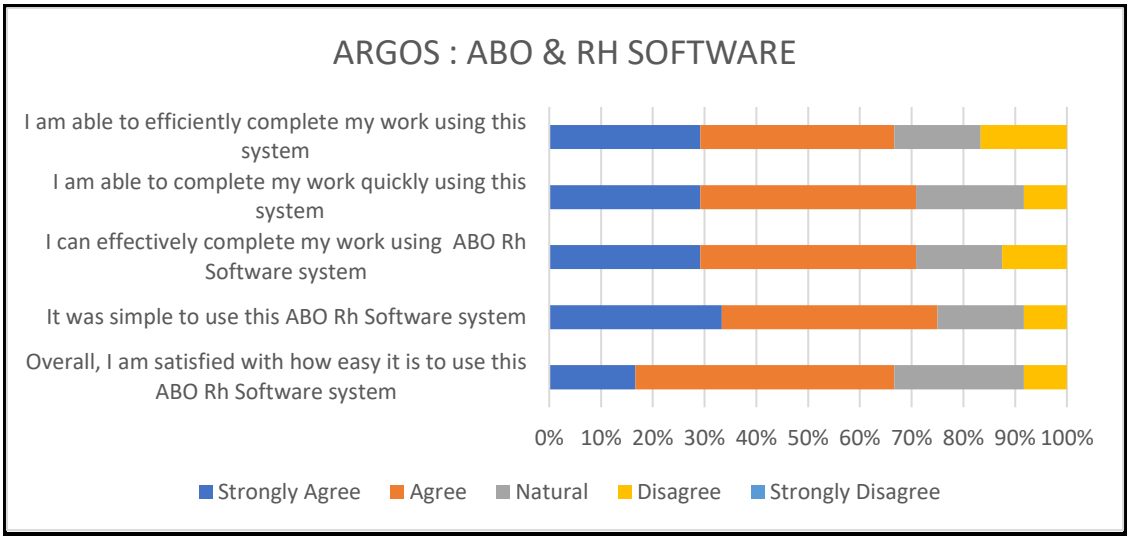

Fig. 1: Satisfaction to ARGOS software use

3.3 Student Attitudes

The participants' attitudes toward the ARGOS software reflect a high level of satisfaction and positive perception of its usability and effectiveness. Notably, a significant portion of participants, representing 37% of the total, expressed strong agreement with statements affirming the ease of understanding the information provided by the system and the simplicity of learning to use it. This indicates that users found the ARGOS software to be intuitive and accessible, facilitating a smooth onboarding process and minimizing any learning curve. Additionally, for statements regarding comfort and productivity, the majority of participants also chose to agree, further highlighting their positive attitudes toward the software. Specifically, 37% of participants indicated agreement with feeling comfortable using the system and believing that they became productive quickly when utilizing it. Once again, the absence of strong disagreements among participants underscores the overall favorable attitude toward the ARGOS software. The widespread agreement among users regarding the ease of understanding, learning, comfort, and productivity associated with the software reinforces its reputation as a user-friendly and efficient tool for educational purposes. These findings validate the success of ARGOS in meeting user needs and expectations, further solidifying its role as a valuable asset in educational settings.

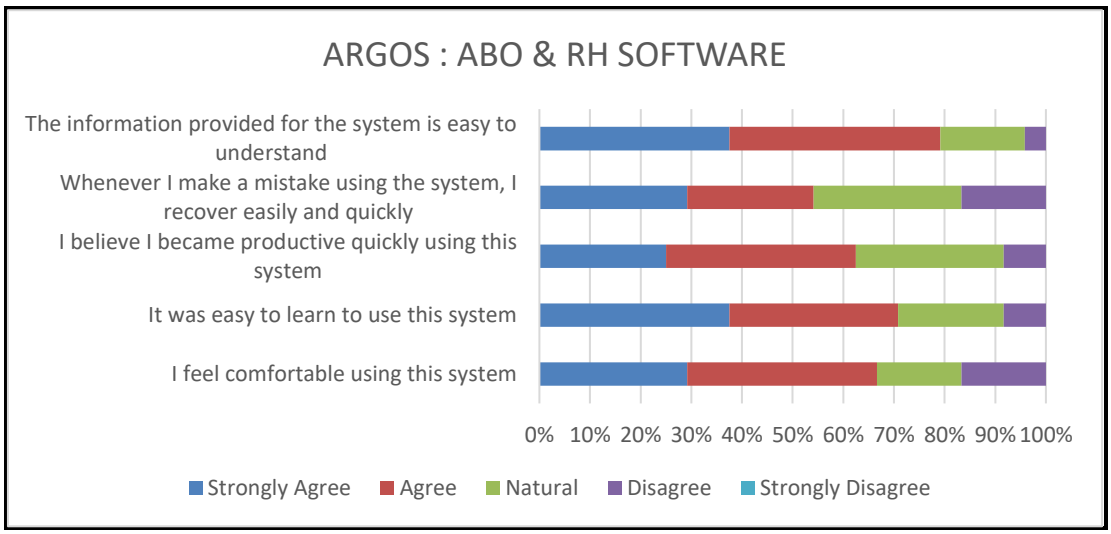

Fig. 2: Attitude to ARGOS software use

3.4 Student Overall experience

In the final section of the survey, the responses further underscore the overwhelmingly positive sentiment among participants regarding their experience with the ARGOS software. The majority of respondents, ranging from 37% to 46%, indicated agreement with all items presented in this section. This widespread agreement indicates a consensus among participants regarding various aspects of their experience, including overall satisfaction with the system and preference for its interface. Notably, the occurrence of disagreement was minimal, with only 4% of participants expressing disagreement with the statements "Overall, I am satisfied with this system" and "I like using the interface of this system." Moreover, no participants indicated strong disagreement with any of the items in this section, further reinforcing the overall positive sentiment. Given that this section focuses on the participants' overall experience with the ARGOS software and the majority of respondents either agreed or

strongly agreed with most items, it can be inferred that a significant proportion of participants expressed a desire to continue using the software in the future. This finding highlights the success of ARGOS in meeting user expectations and satisfaction, indicating its potential for continued use and adoption in educational settings.

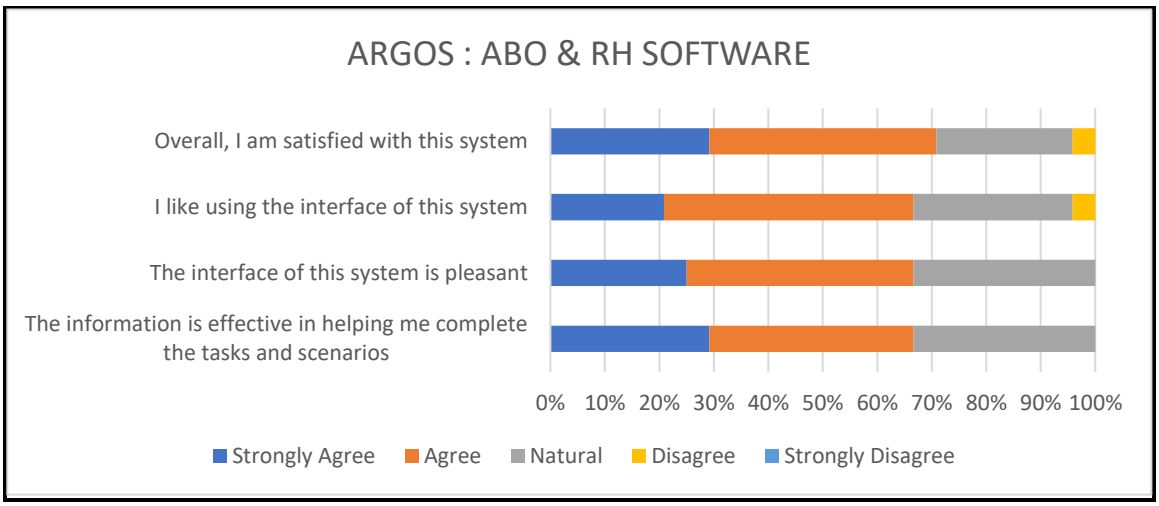

Fig. 3: Overall experience in using ARGOS software

4.0 Discussion

The findings of the study underscore the potential of the ARGOS software as a transformative tool in medical laboratory technology education, with a specific emphasis on its application in transfusion practice. Blood typing procedures are integral to transfusion medicine, where accuracy and precision are paramount for patient safety. ARGOS addresses these critical concerns by enhancing accuracy and minimizing errors in blood typing procedures. Lin et al. (2017) conducted research that underlined the advantages of digital learning, particularly in comparison to traditional educational approaches. They emphasized that digital learning not only boosts learning motivation but also elicits positive effects on overall learning outcomes. This assertion finds support in the work of Noor et al. (2022), who emphasized the pivotal role played by interactive e-learning features in capturing students' interest and consequently enhancing their motivation to engage with course materials. Furthermore, Sousa and Roucha (2018) delved into the specifics of student motivation following the use of digital devices for multiple-choice assessments. Although no significant difference in academic performance was observed between groups, students utilizing mobile devices reported a heightened perception of learning, indicating a positive shift in their educational experiences. Despite the lack of substantial improvement in academic performance, the experimental group demonstrated increased academic motivation when exposed to digital open education platforms. This phenomenon underscores the multifaceted nature of motivation in the digital learning environment. Moreover, digital platforms offer an extensive array of rich and diverse information sources accessible to students at their convenience with minimal effort. This accessibility proves particularly beneficial for students facing limitations in accessing traditional information repositories such as libraries due to geographical constraints or other logistical challenges. Furthermore, in contrast to the more passive learning style often associated with conventional teaching methods, digital platforms empower students to actively engage with course materials, promoting a sense of autonomy and fostering self-directed learning (Li, 2021). This shift towards active participation and personalized learning experiences represents a significant advantage of digital learning environments over traditional instructional approaches.

The utilization of rich network resources in digital learning environments offers students unparalleled access to a vast array of alternative and supplementary information, enriching their understanding of subjects beyond what traditional methods can provide. Seibert et al. (2020) highlight how digital platforms enhance learning experiences by incorporating various multimedia elements such as visuals, sounds, and photos, thereby creating more engaging and appealing teaching materials. This interactive approach fosters deeper comprehension and retention of course content among students. Moreover,digital platforms facilitate two-way communication between students and educators, mirroring the dynamics of face-to-face teaching. Through features like chat rooms and video meetings, students can actively engage with instructors, seek clarification, and participate in discussions, thereby enhancing their learning experience Seibert et al., 2020). Additionally, the flexibility afforded by digital learning is a significant advantage, particularly for students with time constraints or diverse learning schedules. Liu (2020) emphasizes how digital platforms enable students to access teaching materials at their convenience, allowing for repeated review and reinforcement of concepts whenever necessary. This flexibility stands in stark contrast to the rigidity of traditional classroom settings, where students and teachers must gather at specific times and locations. The introduction of ARGOS software further amplifies these benefits, potentially playing a pivotal role in enhancing students' overall academic performance by providing a conducive learning environment that promotes engagement, interaction, and flexibility. By leveraging these digital tools and resources, educators can cater to diverse learning styles, facilitate active participation, and ultimately empower students to achieve their academic goals more effectively.

5.0 Conclusion& Recommendations

In conclusion, the ABO and Rh Profiling (ARGOS) software represents a significant advancement in blood grouping education, offering interactive and personalized learning experiences to students. By leveraging interactive modules, virtual laboratories, and multimedia resources, ARGOS enhances student engagement, comprehension, and retention of complex blood grouping concepts. Moreover, its integration into healthcare settings has the potential to streamline blood typing processes, minimize human error, and ensure safer blood transfusions. However, continued research and development are necessary to further enhance ARGOS's functionality, usability, and integration into educational and healthcare environments. The limitation of this study was its focus on a selected group of students.

To enhance the ABO and Rh Profiling (ARGOS) software's effectiveness, several key steps should be taken. Firstly, ongoing development efforts should focus on expanding ARGOS's features and resources to suit various learning needs and integrate seamlessly into healthcare systems. Secondly, comprehensive training and support programs should be provided to educators and healthcare professionals to ensure proficient use of ARGOS. Thirdly, fostering collaboration among developers, educators, and healthcare practitioners will enable gathering feedback and tailoring ARGOS to user requirements. Additionally, conducting research and evaluations will help assess ARGOS's impact on learning outcomes and transfusion safety. Finally, efforts should be made to ensure ARGOS's accessibility and availability to all users, irrespective of their backgrounds or resources. These measures will maximize ARGOS's potential in revolutionizing blood grouping education and enhancing patient safety in transfusion medicine.

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Paper Contribution to Related Field of Study

The paper shows that using the ARGOS software improves students' understanding and performance in blood grouping. By comparing exam scores, it's clear that students who used ARGOS scored higher. This research fills a gap in knowledge about the effectiveness of digital learning tools like ARGOS in blood grouping education. It suggests that digital platforms can enhance teaching and learning in healthcare settings. The findings are important for educators and healthcare professionals, highlighting the need for training and support to maximize the benefits of digital tools in education and patient care. Overall, the study confirms ARGOS as an effective tool and underscores the potential of digital learning in healthcare education.

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