Issues Ideas Educ. Vol. 10, No. 2 (2022), pp.71–81

CHITKARA

Issues and Ideas in Education

Journal homepage: https://iie.chitkara.edu.in/

Establishing the Practicability of Organic Reaction Teaching Model in Minimizing Student's Common Errors to Improve Academic Performance

Abdulmalik Sabitu, Othman Talib and Norizah Abdul Rahaman

[1]*Department of Science Education, Federal University Dutsin-Ma, Katsina State-Nigeria*

[2]*Department of Science and Technical Education, Universiti Putra Malaysia-43400, Serdang, Malaysia*

[3]*Department of Chemistry, Universiti Putra Malaysia-43400, Serdang, Malaysia*

*asabitu@fudutsinma.edu.ng (Corresponding Author)

ARTICLE INFORMATION

Received: August 16, 2022
Revised: October 15, 2022
Accepted: December 09, 2022
Published Online: January 25, 2023

Keywords:
Teaching model, Organic reaction mechanism, Practicability, Potentiality, Field Testing

DOI: 10.15415/iie.2022.102008

ABSTRACT

Background: Systematic collection of scientific evidence on the applicability an usability of model and its components is an important aspect of design and development research.

Purpose: The aim of this study is to determine external validity of the organic reaction teaching model in terms of its practicability and potentiality in enhancing students' performance scores.

Method: A field testing method was conducted across five matriculation colleges in Malaysia by five (5) experts' chemistry lectures who implemented a lesson plan developed based on the model's constructs and then responded to an open ended questionnaire to express their views on the practicability of the model. 40 matriculation Students that participated in the field testing were also evaluated to determine the potentiality of the model on their performance in organic reactions. Four main themes having of many codes and quotations were identified.

Results: The analysis of the results indicates that the model is compatible, clear and flexible for teaching organic reactions. Moreover, the model components have the potential of miximizing students' academic performance in organic reaction with an overall score of 84.4 % in the organic chemistry tests. Thus, the model was found practicable for teaching and have the potential to minimized students' common errors in organic reaction mechanisms.

Conclusions: The findings of this study may similarly work as a reference model in developing modules and measuring instruments to reduce errors in other procedural concepts in chemistry and other science-related subjects.

1. Background

Models are employed to give a simple framework and a clear explanation for complex real-world circumstances that originally appear chaotic (Gilbert, Boulter, & Elmer, 2000). These philosophical interpretations of reality support both conceptual and cognitive comprehension of the experience (Akaygun, 2016). There are two distinct types of models that might both benefit from validation. The first explains and illustrates the relationships between the design-influencing aspects, while the second offers design tactics (Uzunboylu & Kosucu, 2017). They are models that are both conceptual and procedural (Tracey & Richey, 2007). In procedural models, which start with various forms of analysis, processes include the design of instructional materials and the development of a list of requirements for the Instructional delivery in the classroom(Gustafson & Branch, 2010). Several graphical and sequential representations are used to depict different procedural model components. As a result, the validation processes cover the entire process while the model is being implemented. Models Developed by Ragan, Smith, and Curda (2008) and Dick, Carey, and Carey (2001) are two examples of procedural models that are frequently used in project design. Several variances are mostly expressed in the development process of fundamental model aimed ataddressing the uniqueness of students' classroom, school curricula, mode of dissemination, or even special design principles.

Procedural models included more specific aspects of the design, development, and validation processes. The model of English language communication

ISSN No.: 2320-7655(Print) ISSN No.: 2320-8805(Online); Registration No.: CHAENG/2013/49611

skills for undergraduates (Abdullahi, 2014), skives, the training curriculum model for the engineering education program (Ridhuan, 2016), the higher-order thinking teaching model for basic education students (Ahmed, 2016), and the games-based mobile learning (GBML) model for teaching arithmetic at elementary school were a few examples of the mobile learning program.However, model Developers must ensure the validity and reliability of the models by using logical and clear evidence from the literature (Dutt, Tan, Alagumalai, & Nair, 2019) and are driven by the practical repercussions of its usage as well as the user's satisfaction.

Model validation is the systematic collection of scientific evidence to explain a model's applicability in the field or to demonstrate the utility of its many components. According to Andrews and Goodson (1980), "the model's validity to the actual processes it reflects decreases as the model's specificity decreases." In certain situations, employing a model needs extensive clarification and refinement in order to provide the necessary qualities for implementation. Model validation produces strong concept criteria, which are extensively used as communication tools to foresee and explain the desired approach, as well as to contribute to the conception and implementation of ideas.The internal validity of the model lies on the classification of activities, their relationships and the usability of model components that can be established from by the experts in the discipline the model was intended to be implemented. This types of validity have been established by many researchers through various methods such as experts' evaluation, fuzzy Delphi and nominal group technique (Abdullahi, 2014 & Ridhuan, 2016).

However, while establishing the model's validity, some common concerns should be addressed. These include establishing the validity of the results, generating conditions that allow causal inferences and claims to be credible, and assisting with the generalization and interpretation of findings. Thus, external validity of the model is needed in order to ensure the practicability and potentiality of the model. External validity of the model entails determining the degree to which conclusions about the model's use are acceptable and substantive.

The process of collecting and evaluating empirical information to establish the usage of a model designed to enhance the model's many structures and instructional activities, particularly the Organic Reaction Teaching Model, is referred to as external validity of the model in this article (ORTM). This is a teaching model develop based on students' practices and experts' collective opinion through contents analysis and two rounds of traditional Delphi method. consists of 30 instructional activities organized into 5 dimensions: symbolism, mechanisms, visualization, cross-cutting, and reflection, which are then grouped into 3 domains, including treatment, avoidance, interference, and correction.The components of the model were evaluated by experts through fuzzy Delphi evaluation to indicate internal validity which revealed its usability. This study was designed to give evidence to support the main aim of the study, which was to validate the practicability and potentiality of the ORTM model from the practitioners' views. As a result, the following research questions are addressed in this paper:

1. How does the ORTM help lecturers to improve students' understanding of organic reaction mechanisms?
2. What is the potentiality of ORTM in helping students to minimize common errors in organic reaction mechanisms?

2. Methodology

An exploratory sequential design that sequentially utilizes both qualitative and quantitative approaches in the data collection was adopted in this study. The organic reaction teaching model ORTM was implemented by chemistry subject matter experts through field testing method. This method is used primarily to collect qualitative data for determining the practicability of the model from the perspective of the lecturers, and quantitative data to establish the potentiality of the model from the students' perspectives as the end users of this educational product.

Field testing is described as the usage of a programs or product on many sites similar to those for which it was designed, with the primary goal of collecting data on the practicability and potentiality of that program or product (Altschuld & Hines, 1982). The field test activities were usually conducted in numerous locations, especially in instances where the program, product, tool, or model would be used. The procedure of the field testing was based on the following steps: Selection of matriculation chemistry lecturers as participants, training of lecturers, teaching of the students using ORTM lesson plan, interviewing of lecturers and data analysis. The field testing was conducted with a lesson plan developed based on the ORTM components. The respondents comprised of five chemistry lecturers and 40 matriculation students from five chemistry matriculation colleges. The lecturers were purposely chosen based on their experience and knowledge of the field. Each of the experts invited and participated in the field testing received a 200RM gift card as compensation for implementation of the model and completing the open ended questionnaire. A total of four instruments were used in the field testing process; two instructional and two measurement instruments. These include: ORTM implementation Guide, ORTM lesson plan, ORM academic achievement test and lecturers' interview protocol. These were explained in detail as follows:

The ORTM implementation guide provides detailed facilitation notes to fully support lecturers' delivery process. This valuable resource provides point-of-use support that serves as lecturers' primary resource for implementing organic reaction mechanisms. The ORTM implementation Guide was developed by the researcher for training the lecturers on how to teach matriculation students reaction mechanisms using the organic reaction teaching model. It is a step by step action plan of the implementation of the model components to ensure the practicability and potentiality of the model in actual classroom situation. The guide is therefore activity based and it showed steps to be followed and the role of the lecturer and the students. It gives both lecturer and the students in the class opportunity to participate actively during the lesson.

ORTM Lesson Plan was planned based on the model constructs as the main steps for the lesson delivery. The model instructional activities were used as guide for the presentation of the lecturer and the students' role during the lesson. The logical presentation of the lesson was based on the three error domains of the model.ORM academic achievement test instrument was adopted from (Azraai, 2016). The original instruments comprised of 40 items measuring students' performance in organic chemistry. The instrument was modified and only items testing students' achievement in reaction mechanisms were considered and adopted in this study. Thus it contains 20 items dully validated by three experts in chemistry.

The open-ended questionnaire comprises of thirteen (13) questions that allowed the lecturers to write open responses in their own words. Lecturers were invigorated to use their own knowledge and express their own feeling in their experience with ORTM lesson plan. Questions in the open-ended questionnaire were designed to ask lecturers to give their opinion about the practicability of the model that might help them to understand the topic better and minimize errors in ORM. Thus, the main objectives of the open-ended questionnaire are to identify the practicability and determine the potentiality of the ORTM lesson in helping the students to minimize common errors in ORM. Earlier on, the respondents were requested to fill their personal details and consent forms. The personal details and consent forms templates. The open ended questionnaire were administered to the respondents after teaching their students using ORTM lesson plan. The open ended questionnaire was retrieved from the lecturers for the data analysis. All the information obtained from the questionnaires were analysed into themes, codes, and quotations.

3. Findings and Discussion

The external validity of the model was determined using field testing method. In the process, a lesson guide was developed and used for training matriculation chemistry lecturers to teach matriculation students in five different matriculation colleges in Malaysia. the field testing evaluation method was employed as a technique to determine the external validity in term of practicability, and potentiality of the model in minimizing students' common errors in organic reaction mechanisms.

4. Findings on Practicability of the Model

Field testing was conducted across five selected matriculation colleges to determine the practicability and potentiality of the model. According to Englander (2016), the individual participating in the qualitative research must have a common experience on such a phenomenon to be investigated. Thus, five experienced matriculation chemistry lecturers in Malaysia were purposively selected and interviewed to ascertain the practicability of the model. The five respondents were selected based on their vast knowledge and experiences in teaching and learning in the field of organic chemistry. They were trained and requested to use ORTM lesson plan to teach and assess the students' performance and then responded to the open ended questionnaire to share their views on the practicability and potentiality of the ORTM lesson plan in the actual classroom situation. The questions asked in the open ended questionnaire were meant to answer the research question as follows: RQ1: How does the ORTM help lecturers to improve students' understanding of organic reaction mechanisms? Four main themes were emerged from the responses of the lecturers after implementing the model in the real classroom situation. These include; compatibility, clarity of stages, efficiency, and flexibility.

5. Theme One: Compatibility

In order to improve model practicability and potentiality, attention must be paid to the compatibility of the model components versus teachers and students activities (Umoren&Ogong, 2007). This played an important role in improving the amount of knowledge the students can gain from the lesson delivered in the classroom. This section presents the findings from the field testing among the matriculation lecturers in Malaysia. Adjustable and Friendly were two codes identified under the theme of the ORTM compatibility. Figure 1 depicts the emergent theme, codes and related quotations from the perspectives of the experts.

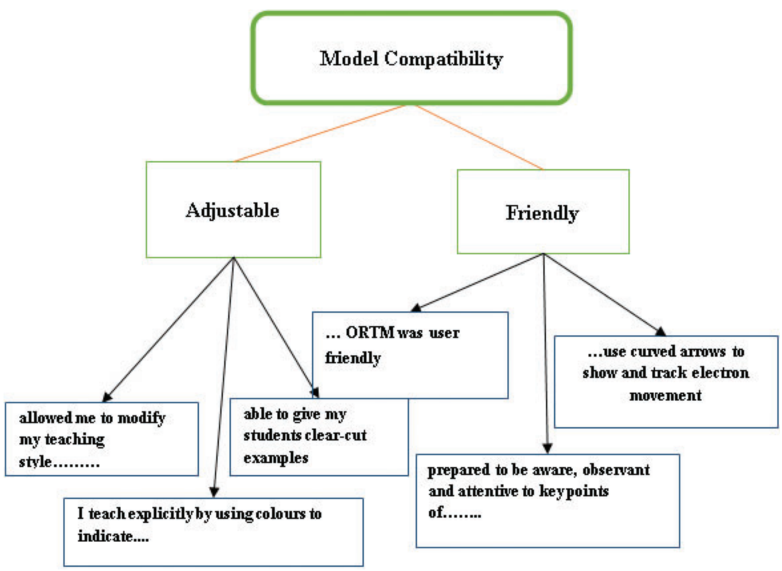

Figure 1: ORTM Compatibility.

Extracts from the experts indicated that organic reaction teaching model (ORTM) components are compatible and user-friendly to them. They lamented that the model constituents as domains, constructs and instructional activities make it easily for them to adjust their teaching styles for explicit presentation of abstract parts of the organic reactions. The model constructs and instructional activities makes the lesson planning easily and engaged both teachers and the students during the lesson. Experts 2 said that "*the lesson planned using ORTM makes me to modify my teaching style by allowing me to cite Hans-on activities to the students*". Experts 5 supported this statement by stating that "*with ORTM lesson plan I teaches explicitly by using colours and expanded structures to indicate functional groups, bonds and lone pairs to the students* ".

Using arrow (s) to illustrate electron movement increased working load to the students, particularly on how to locate the source and destination of the arrows. However, the instructional activities in the symbolisms and mechanisms constructs of the model provide teachers with options on how to simplify the used of arrow in writing reaction mechanisms. This was agreed by experts 1 who lamented that "*I was able to give my students clear-cut examples on how to use curved arrows to show and track electron movement during reaction mechanisms as presented in the ORTM lesson plan*". Teaching models are meant to simplify the way teachers communicate to their students with aim of making lessons simple, interesting and enjoyable to the students. These could be achieved by planning and delivering lesson that encourages students' active participation. Experts 3 said, " *lesson planned base on ORTM was user friendly, the lesson plan allow mystudents to performed hands-on activities to show electron movement explicitly using arrows*". This view was confirmed by Lecturer 4, who stated that "*because of the suitability of instructional activities in the model my students became prepared to be aware, observant and attentive to key points of the lesson*". Thus, from the perspectives of the experts, who implemented the model, it was deduced that the ORTM was practicable in terms of compatibility of its components for ensuring students active learning and increases student-teacher and student-students interaction during lesson.

6. Theme Two: Clarity of Stages

For teaching model to be practicable, it must have a number of components being perceived by the end users as clear. Teaching model should indicate clearly, the various types of instructional activities in order of priority for ease of implementation in the classroom based on the nature of the subject matter and the level of the students (Muqsith et al., 2017). Therefore, model must orient and prepare teachers and students for what is to be taught; and provide illustrations and examples; use a variety of instructional materials; so that students understanding could be improve. The domains, constructs and instructional activities of the ORTM are organized in such a way that teaching is in a step-by-step manner; stressing directions and difficult points, provide practices and rules for satisfactory performance from the students' feedback. The emergent theme, codes and related quotations from the perspectives of the experts after implementing ORTM in the actual classroom. logical and comprehensibility were two codes that emerged under the theme of the ORTM clarity theme as shown in Figure 2.

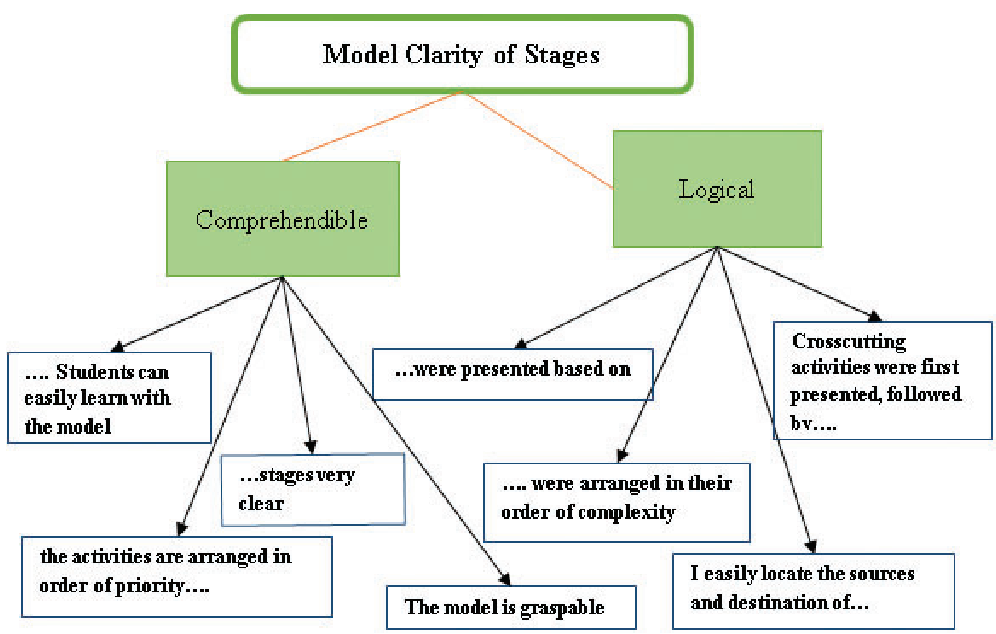

Figure 2: ORTM Clarity.

All the five lectures agreed that the components of the ORTM are clearly arranged to simplify planning and implementation of the lesson. Furthermore, the instructional activities were arranged to enable easy students' comprehension. For example, expert 1 said, "*...I foundthe ORTM model stages very clear, because the activities are arranged in order of priority...*". This was supported by expert 5 who stated, that "*... instructional activities were presented based on the reasons the ORTM model was developed, he added* *that, symbolisms and crosscutting activities were first presented to help students avoid errors followed by visualization, mechanisms and reflection activities to interfere and correct the errors already made by the students. . . ..".*

Similarly, experts 3 reported that "... *I easily understand the model components because of the way they were arranged in their order of complexity from simple to complex.".* Expert 4, added that "*I believe the model stages are okay from the way my students and I are freely interacting while the lesson is taking place..."* this was supported by expert 2, who reported that "… *I was surprised, the way my students easily learned how to locate the sources and destination of electrons in writing reaction mechanisms*". Therefore, from the aforementioned after implementing of the ORTM lesson, its deduced that the stages of ORTM are very clear since the model lesson can be easily understood by both lecturers and the students.

7. Theme Three: Model Efficiency

Learning efficiency is measured by the ratio between potentiality and the amount of time and learning resources used (Kristiono, Dwiyogo&Hariadi, 2019). Analysis of the results shown three related codes under the model efficiency theme: resources, time and personnel. The emerging codes and related quotes were depicted using schematic diagrams in Figure 3.

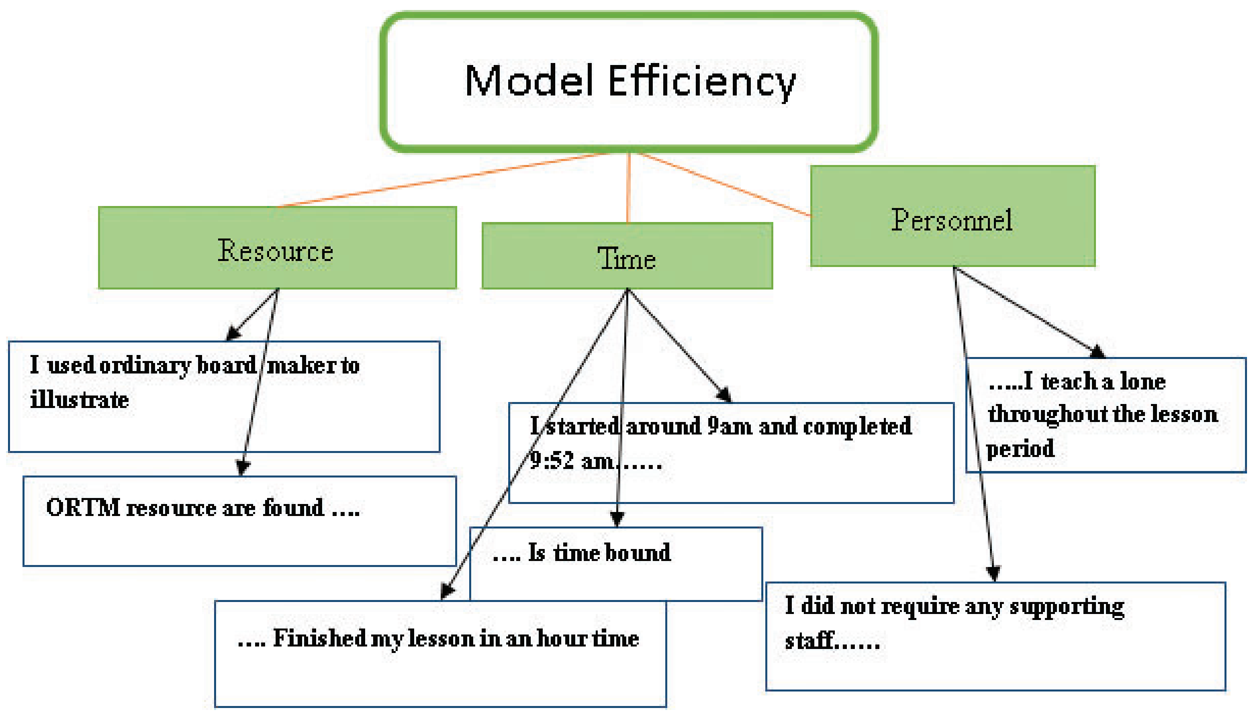

Figure 3: Model Efficiency.

From the results, related quotes were obtained from the lecturer's views. Analysis of the results shows that all the five experts agreed that ORTM model is efficient in teaching organic reaction mechanisms. Since the model was implemented by the regular teachers in different locations without requiring more resources and additional personnel. Quoting experts 2's words "… *I did not require any supporting staff before implementing ORTM lesson plan in my classroom*". Experts 4 supported this statement by stating that *"…. I teach a lone throughout the lesson period, I was relaxed when students are busy with their activities already incorporated in the ORTM lesson plan...*".

The period of time allocated to the teacher is very important for covering the syllabus (Tobin & Gallangher,1987; Dejene, 2019). Thus, an efficient lesson plan should be completed within the time frame allocated in the school timetable (Nworgu&Oluwuo, 2019). Experts 3 stated that, "…. *I spent less time than* *usual when teaching with ORTM lesson plan, I started around 9am and completed by 9:52am, less than 1hour.".* This statement was further supported by Expert 5 who in addition noted that; "…*ORTM lesson plan is time bound in performing hands-on activities by the students, it took me exactly an hour to complete my lesson…..".* The use of resources in form of audio, visual and audio-visual are crucial in delivering effective lessons (Dwiyogo&Radjah, 2020). The use of technology gadget in the teaching of science have been widely reported in the literature (Mama & Hennessy, 2013; Ali, 2020; Lim et al., 2021).

However, technology driven lessons are associated with technical challenges related to power supply and internet access especially in remote areas. Thus, ORTM lesson were planned to be implemented with common resources available in nooks and crannies of the country. Quoting expert 4 statement, "…*I used ordinary white board maker to explicitly illustrate abstract part of organic compound such as bonds, lone pairs and functional groups when implementing ORTM lesson….".* This view was also reported by expert 2 who stated that "……*I only made little amendment on my lecture notes in teaching organic reaction using ORTM lesson plan*…". The Other experts stated that they did not require any special resources in implementing ORTM lesson plan. Thus, the results indicate that ORTM lesson is practically efficient in terms of time, resources and personnel needed in teaching organic reaction mechanisms for better students understanding.

8. Theme Four: Model Flexibility

The validity of the teaching model depends on its flexibility to meet the needs of its users (Deldjoo et.al., 2021). This model provides the teacher with the options to adapt different strategies of teaching to improve students understanding of mechanisms of organic reactions. The model components allow teachers with a coherent teaching ideology to manage and tract the consistency in teaching organic reactions. This theme includes two codes: adaptable, and manageable as depicts in Figure 4 as follows:

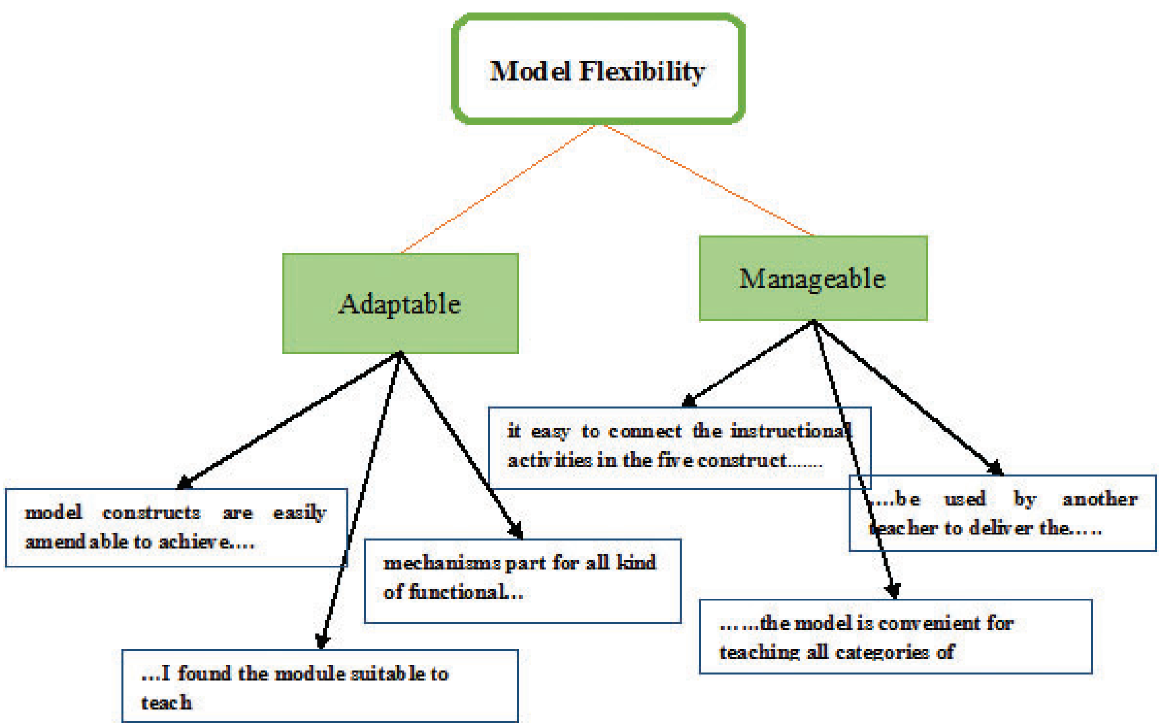

Figure 4: Model Flexibility.

Under the model flexibility theme, all the five experts agreed that modules can be developed using ORTM for teaching organic reaction mechanisms of different functional groups. This is an exceptional characteristic of ORTM for being adaptable in planning lessons to teach vast number of reactions mechanisms despite its spiral nature in the organic chemistry syllabus. For example, experts 1 reported that, "…. *the instructional activities in the model constructs are easily amendable to achieve many objectives of the lesson…".* Expert 4 supported this statement by reporting that *"…. I was able to modified the instructional activities of the model to guide my students to avoid, interfere and correct errors in ORM".*

Reaction mechanisms varies depending on many factors such as classes of reacting compounds, conditions of the reaction and the reaction medium. Thus, a rigid model is antithetical to the effectiveness in any instruction (Wong & Day, 2009). Nonetheless, expert 3 stated that, "……*because of the integration of the symbolisms, mechanisms and visualization activities in the ORTM, I found the module suitable to teach organic chemistry mechanisms for all types of reaction like elimination, substitution and addition reactions…*" Similarly, expert 5, stressed that "…. *when implementing ORTM lesson plan, I used many examples from other topics of organic chemistry syllabus especially in teaching mechanisms part for all kind of functional groups*.". This shows that the model components are not only suitable as reported by experts during the internal validation but adaptable for teaching all types of organic reaction mechanisms. Moreover, expert 2 stated that "…. *I found it easy to connect the instructional activities in the five constructs of the model…".* Expert 1 supported this statement by reporting that *"…. the model components were related and agreed with each other…"* Lastly, Expert 3 noted that "…. *the classroom was interactive, I can say the model is convenient for teaching all categories of students, the fast, and slow learners…….".* According to Nworgu and Oluwuo (2019), one of the good attributes of a lesson plan is to allow another teacher to deliver the lesson to the students when their regular teacher is absent. To attest the quality of ORTM base lesson plan, expert 3 noted that, *"…because of the logical arrangement of the instructional activities in the ORTM lesson plan, it can be used by another teacher to deliver the lesson…"* Thus, teaching module to be developed using the ORTM might to be found flexible since it can be adapted in teaching all types of organic reaction mechanisms for different categories of students and can be transferable to other teachers if need arises as lamented by the end users after testing it in the real classroom situation its intended for.

9. Findings on Potentiality of the Model

The potentiality of organic reaction teaching model was ascertained by measuring the students' academic performance. Since the measurement of academic performance must always be associated with the stated objectives. Therefore, this section provided data on the average performance of the students in ORM Academic Achievement Test administered by the lecturers after teaching with ORTM lesson plan.

The students' scripts were marked and assigned scores from 0 to 100, the average students' performance in the test indicates the potentiality of the model in improving students' understanding by minimizing their common errors in ORM. The questions asked in the ORM Academic Achievement Test was aimed at answering research question RQ2: What is the potentiality of ORTM in helping students to minimize common error in organic reactions mechanisms? Average performance scores of the students in each of the five matriculation colleges were calculated as presented in Table 2.

Table 2: Average Students' Performances in ORM Achievement Test.

College	Number of Students	% Average Scores
Matriculation College A	08	89.6
Matriculation College B	09	76.9
Matriculation College C	07	88.7
Matriculation College D	10	77.8
Matriculation College E	06	89.2
Total	**40**	*84.4

*Overall Average score is 84.4%

From the analysis of the result in Table 2, the model is found potential in improving students understanding of ORM with an overall average score of 84.4%. Thus, teaching with ORTM lesson plan has minimize students' common errors as reflected in the students' scores.

Thus, the results of the external validation of the ORTM was performed using the procedure described in the methodology section. Comprising of two main parts that are, qualitative and quantitative data. The first part, is a qualitative analysis which presented findings to answer RQ1. of this study, on how does the ORTM help lecturers to improve students' understanding of organic reaction mechanisms? The last part is a quantitative data which presented the findings to answer RQ2; what is the potentiality of ORTM in helping students to minimize common errors in organic reaction mechanisms. It is, therefore, agreeable that all lecturers indicate that ORTM is practicable in teaching organic reaction mechanisms in their classrooms and it helped in improving their students' performance and minimized their errors when exposed to ORTM lesson plan. This finding was supported by a quantitative data that revealed how the newly developed lesson plan using ORTM is able to improve students' performance significantly higher as it minimized their errors in organic reaction mechanisms.

Conclusion

The practicability and potentiality of ORTM was determined to establish its external validity that provided the quality of the model and assurance for its replication in other settings. The ORTM lesson plan was found flexible, compatible, and efficient in practice when implemented in the classrooms of the five matriculation colleges. Therefore, the model is both practical and potential in helping both teachers and their students to achieve their learning objectives and minimize common errors in organic reactions.

Recommendation

Although the aim of ORTM is to minimize students' common errors by improving conceptual understanding among matriculation students in organic reaction mechanisms, the findings of this study may also serve as a reference model for developing modules to reduce errors in other procedural concepts in other science-related subjects. The study further, suggested the used of field testing method in validating instructional model in the field of curricula and instruction.

References

Abdullah, M. R. T. L., Siraj, S., Asra, & Hussin, Z. (2014). Interpretive Structural Modeling of Mlearning Curriculum Implementation Model of English Language Communication Skills for Undergraduates. *Turkish Online Journal of Educational Technology*, *13*(1), 151–161.

Ahmed, G., & Artosh, M. (2016). Development of a Higher Order Thinking Teaching Model for Basic Education Students in Science. In Thsesis Doctor of Philosophy. University Malaya, Malaysia.

Akaygun, S. (2016). Is the Oxygen Atom Static or Dynamic? The Effect of Generating Animations on Students' Mental Models of Atomic Structure. *Chemistry Education Research and Practice*, *17*(4), 788-807. https://doi.org/10.1039/C6RP00067C

Ali, W. (2020). Online and Remote Learning in Higher Education Institutes: A necessity in light of COVID-19 Pandemic. *Higher Education Studies*, *10*(3), 16-25. https://doi.org/10.5539/hes.v10n3p16

Altschuld, J. W., & Hines, C. V. (1982). Factors Affecting the Validity of Field Tests in Education. *Educational Evaluation and Policy Analysis*, *4*(3), 331–339. https://doi.org/10.3102/01623737004003331

Andrews, D. H., & Goodson, L. A. (1980). A Comparative Analysis of Models of Instructional Design. *Journal of instructional development*, *3*(4), 2-16. https://doi.org/10.1007/BF02904348

Azraai, O. (2016). Modeling Relationships of Matriculation Students' Affective and Cognitive Factors and Achievement in Organic Chemistry. In *Universitas Putra Malaysia*. University Putra Malaysia

Dick, W., Carey, L., & Carey, J. O. (2001). The systematic design of instruction. 6th. *New York: Longmann*.

Dutt, A., Tan, M., Alagumalai, S., & Nair, R. (2019). Development and Validation of the Ability in Behavior Assessment and Interventions for Teachers Using Delphi Technique and Rasch Analysis. *Journal of Autism and Developmental Disorders*, *49*(5), 1976–1987. https://doi.org/10.1007/s10803-019-03887-4

Deldjoo, Y., Anelli, V. W., Zamani, H., Bellogin, A., & Di Noia, T. (2021). A flexible Framework for Evaluating User and Item Fairness in Recommender Systems. *User Modeling and User-Adapted Interaction*, 1-55. https://doi.org/10.1007/s11257-020-09285-1

Dejene, W. (2019). The Practice of Modularized Curriculum in Higher Education Institution: Active Learning and Continuous Assessment in Focus. *Cogent Education*, *6*(1), 201-221. https://doi.org/10.1080/2331186X.2019.1611052

Djoko Dwiyogo, W. & LigyaRadjah, C. (2020). *Effectiveness, Efficiency and Instruction Appeal of Blended Learning Model*. International Association of OnlineEngineering. Retrieved October 12, 2021 from https://www.learntechlib.org/p/217970/.

Englander, M. (2016). The Interview: Data collection in Descriptive Phenomenological Human Scientific Research. *Journal of Phenomenological Psychology*, *47*(1), 13–35. https://doi.org/10.1163/156916212X632943

Gilbert, J. K., Boulter, C. J., & Elmer, R. (2000). Positioning Models in Science Education and in Design and Technology Education. *Developing Models in Science Education* (pp. 3-17). Springer, Dordrecht. https://doi.org/10.1007/978-94-010-0876-1

Gustafson, K. L., & Branch, R. M. (2002). What is Instructional Design. *Trends and Issues in Instructional Design and Technology*, *2*, 10-16.

Abdurrahman Alkhaldi, I. A., Talib, O. B., Kamarudin, N. B., & Ab Jalil, H. (2020). Covid-19 and the Need for the use of Digital Game-based Learning for Teaching Mathematics at the Saudi Elementary Schools. *Compusoft*, *9*(12), 3953-3959.

Kristiono, I. D., Dwiyogo, W. D., & Hariadi, I. (2019). Sports Nutrition Science Learning Based on Blended Learning in Physical Education, Health, and Recreation Students. *Journal of Education: Theory, Research, and Development*, 4 (2), 235-241.

Lim, J. E., Wong, W. T., Teh, T. A., Lim, S. H., Allen Jr, J. C., Quah, J. H. M., & Tan, N. C. (2021). A Fully-Immersive and Automated Virtual Reality System to Assess the Six Domains of Cognition: Protocol for a Feasibility Study. *Frontiers in Aging Neuroscience, 482*. https://doi.org/10.3389/fnagi.2020.604670

Mama, M., & Hennessy, S. (2013). Developing a Typology of Teacher Beliefs and Practices Concerning Classroom Use of ICT. *Computers & Education*, *68*, 380-387. https://doi.org/10.1016/j.compedu.2013.05.022

Muqsith, A., Zaharah, Farazila, A., Yusof, H., & Mohd Ridhuan, J. (2017). Nominal Group Technique (NGT) And Its Application To The Construction Of Ethical Elements and Values (Morals) Based on Inquiry Activities in Polytechnics and Community Colleges. *Journal of Social Sciences and Humanities*, *2*(1), 125-145

Nworgu, C., &Oluwuo, S. O. (2019). Time Resource Management and Teachers' Task Performance in Public Senior Secondary Schools in Rivers State. *International Journal of Education and Evaluation*, *5*(6), 36-48.

Ragan, T. J., Smith, P. L., & Curda, L. K. (2008). Outcome-Referenced, Conditions-Based Theories and Models. *Handbook of research on educational communications and technology*, *3*, 383-399.

Ridhuan, M. B. M. J. (2016). Development of Skives Training Curriculum Model for Work -Based Learning Engineering Study Program. In Thsesis Doctor of Philosophy. University Malaya, Malaysia.

Tobin, K., & Gallagher, J. J. (1987). What happens in high school science Classrooms? *Journal of Curriculum studies*, *19*(6), 549-560. https://doi.org/10.1080/0022027870190606

Tracey, M. W., & Richey, R. C. (2007). ID Model Construction and Validation: A Multiple Intelligences Case. *Educational Technology Research and Development*, *55*(4), 369-390. https://doi.org/10.1007/s11423-006-9015-4

Umoren, G., & Ogong, A. S. (2007). Prior presentation of Behavioral Objectives and Students' Achievement in Biology. *Educational Research and Reviews*, *2*(2), 022-025

Uzunboylu, H., & Kosucu, E. (2017). Comparison and Evaluation of Seels& Glasgow and Addie Instructional Design Model. *Ponte*, *73*(6), 98-112.

https://doi.org/10.21506/j.ponte.2017.6.37

Wong, K. K. H., & Day, J. R. (2009). A comparative study of problem-based and lecture-based learning in junior secondary school science. *Research in Science Education*, *39*(5), 625-642. https://doi.org/10.1007/s11165-008-9096-7

Issues and Ideas in Education

Chitkara University, Saraswati Kendra, SCO 160-161, Sector 9-C,
Chandigarh, 160009, India

Volume 10, Issue 2 **September 2022** **ISSN 2320-7655**