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EFFECT OF DIGITISED REVERSE JIGSAW INSTRUCTIONAL STRATEGY ON REMEDIATING UNDERGRADUATES' MISCONCEPTIONS IN CELL BIOLOGY IN ONDO STATE, NIGERIA

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Abstract. This study investigated the effect of a digitised reverse jigsaw instructional strategy on remediating misconceptions in Cell Biology among undergraduates in Ondo State, Nigeria based on their gender. Two purposes and two hypotheses guided the study. Quasi-experiment of pre-test, post-test, non-equivalent and non-randomised control group design using 2x2 factorial designs was adopted for the study. A simple random sampling technique was used to select 32 undergraduates across two universities that participated in this study. The research instrument used for the collection of data was a Cell Biology Conception Test (CBCT). The CBCT was given to three experts in the Department of Biological Sciences, Al-Hikmah University, Ilorin for face and content validity. The reliability of CBCT was determined using the test-retest method and after the two-week interval, the data was calculated using Cronbach Alpha and a reliability index of 0.81 was obtained. The data collected was analysed using t-test statistics at 0.05 level of significance. This study found a significant difference in the number of misconceptions remediated between students taught using the digitised reverse jigsaw strategy and those taught using conventional teaching methods. More so, gender does not influence the misconceptions remediated in the digitised reverse jigsaw group. It is recommended that lecturers incorporate a digitised reverse jigsaw instructional strategy into biology instruction in other to improve undergraduates' understanding by helping them remediate their misconceptions about biology.

Keywords: *Remediating, Misconception, Digitised Reverse Jigsaw Instructional, Cell Biology*

Abstrak. *Studi ini menyelidiki pengaruh strategi pembelajaran digital reverse jigsaw dalam memulihkan kesalahpahaman dalam Biologi Sel di kalangan mahasiswa sarjana di Negara Bagian Ondo, Nigeria berdasarkan jenis kelamin mereka. Dua tujuan dan dua hipotesis memandu penelitian ini. Penelitian ini menggunakan desain eksperimen kuasi pre-test, post-test, non-equivalent dan non-randomised control group design dengan menggunakan desain faktorial 2x2. Teknik simple random sampling digunakan untuk memilih 32 mahasiswa sarjana di dua universitas yang berpartisipasi dalam penelitian ini. Instrumen penelitian yang digunakan untuk pengumpulan data adalah Tes Konsepsi Biologi Sel (CBCT). CBCT tersebut diberikan kepada tiga ahli di Departemen Ilmu Biologi Universitas Al-Hikmah, Ilorin untuk validitas wajah dan isi. Reliabilitas CBCT ditentukan dengan metode test-retest dan setelah selang waktu dua minggu, data dihitung menggunakan Cronbach Alpha dan diperoleh indeks reliabilitas sebesar 0,81. Data yang dikumpulkan dianalisis menggunakan statistik uji-t pada tingkat signifikansi 0,05. Studi ini menemukan perbedaan yang signifikan dalam jumlah miskonsepsi yang diremediasi antara siswa yang diajar menggunakan strategi digital reverse jigsaw dan mereka yang diajar menggunakan metode pengajaran konvensional. Terlebih lagi, gender tidak*

mempengaruhi miskonsepsi yang diperbaiki dalam kelompok digitalisasi reverse puzzle. Direkomendasikan agar para dosen memasukkan strategi pembelajaran digital reverse jigsaw ke dalam pengajaran biologi untuk meningkatkan pemahaman mahasiswa dengan membantu mereka memperbaiki kesalahpahaman mereka tentang biologi.

Kata Kunci: Remediasi, Miskonsepsi, Digitised Reverse Jigsaw Instruksional, Biologi Sel

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INTRODUCTION

Biology is the branch of science that focuses on the study of living organisms and their interactions with one another and their environments. It is a vast and diverse field, encompassing everything from the smallest microscopic organisms to the largest ecosystems on Earth. The word biology comes from the Greek words *bios* (meaning life) and *logos* (meaning study), reflecting its fundamental role in understanding life itself. Biology seeks to answer key questions about the nature of life and it can be explored through various subfields, each focusing on different aspects of life such as cell biology, genetics, ecology, anatomy physiology and evolution among others. Jeronen *et al*. (2017) noted that these topics in Biology such as ecology, cell biology, metabolism, osmosis, and so on, require approaches which promote experimental problem-solving and process-based skills. According to Ogbuze and Okoli (2020), nearly all science and art students choose biology when they enrol for senior secondary classes. The reason is that biology serves as a prerequisite subject for many fields of study and professions such as medicine, nursing, pharmacy, microbiology, biomedical technology, biochemistry, and other related disciplines (Adesola *et al*. 2022). Thus, it contributes immensely to the national development.

Cell Biology is the study of cells, which are the basic building blocks of life. All living organisms, from bacteria to humans, are made up of one or more cells. Cell biologists explore the structure and function of cells, as well as how they communicate and reproduce. The cell is the smallest, simplest, basic, fundamental, structural and functional unit of a living organism capable of independent existence from which organisms are built or made up. The discovery of cells was because during the nineteenth century, there were dramatic improvements in the quality of lenses for use in microscopy and this in turn led to great interest in the structure of living organisms. The cell theory was proposed jointly by two scientists, namely Schleiden and Schwann (Biological Science, 2010).

"*The cell is the structural and functional unit of life. All living organisms are made up of cells either unicellular or multicellular. All cells come from pre-existing cells by cell division. All living cells are either single cells or groups of cells. All cells contain hereditary materials in the nucleus that carry unique*

information from generation to generation".

Matazu (2022) posited that cell biology is a very important subject for technological development. The subject is fundamental for individual well-being, the development of good living environment and the acquisition of functional scientific attitudes. It is therefore imperative that undergraduates are well-grounded in cell biology which could help Nigeria to attain the state of national development it desires (Nuhu *et al*. 2021).

Despite the importance of Biology, the performance of students in the subject is still unimpressive (Abimbola, 2013; Adeoye *et al*. 2022). The teaching style of teachers could be one of the reasons for the difficulties faced by students. Most teachers usually use teacher-centred methods rather than student-centred strategies. Hadiprayitno, *et al*. (2019) submitted that the difference between actuality and classroom learning experiences causes difficulties in learning Biology. Researchers like Ibe (2015) and Adegboye *et al*. (2017) attributed students' unimpressive performance in Biology to teachers' insensitivity to the nature of Biology especially when planning instructional activities. Also, Avwiri and Okoli (2021) and Udegbe and Okoli, (2022) submitted that the use of teacher centred instructional strategy, the large content scope of the Biology curriculum, lack of adequate supply of instructional materials contributed to students' unimpressive performance in Biology. In contrast, Cetin *et al*. (2015) and Abubakar and Jimin (2018) suggested that misconceptions of Biology concepts serve as one of the factors affecting students' performance in the subject.

Misconceptions are conceptions or knowledge that is incorrect or inconsistent with scientific ideas which can arise from culture, ethnicity, religion, social interaction with others and the physical environment. The National Research Council (2012) defined misconceptions as understandings or explanations that differ from what is known to be scientifically correct. A misconception occurs when someone believes that a concept is objectively wrong. In connection with the nature of human subjectivity, it can be assumed that everyone always has a misconception.

Students' misconceptions about cell biology and genetics have been a persistent challenge in biology education. Therefore, the identification of misconceptions and other barriers to study is an important and obvious stage in the remediation of students' poor performance and bridging the achievement gaps that exist among students with numerous mental abilities (Adeoye & Abimbola, 2016). Hence, to equip students with the right conceptions, all teachers need to adopt new and innovative ways to identify and correct students' misconceptions. This is in line with Eshach's (2014) submission that the identification of prior knowledge and misconceptions among students is an indispensable stage in the instructional delivery process and this may empower educators to structure viable learning situations that help reshape students' prior understanding into scientifically accepted understanding. Student misconceptions are obstacles in learning science courses and unless remediated may continue causing difficulties as students advance in their studies. Therefore there is a need to remediate the misconceptions identified in cell biology among undergraduates through innovative instructional delivery which contains suggested pedagogical

techniques that will be used to correct students' misconceptions on biology concepts. Cooperative learning has become entrenched in the teaching-learning situation as an instructional strategy with great potential and impact (Ogunleye, 2013). Cooperative learning allows students to work together in small groups, with each participating in the learning process along structured activities. The essence of cooperative learning strategies is to ensure the active participation of every member of the learning group, engender team spirit, entrench accountability and foster social cohesion among the work groups (Ogunleye & Oladehin, 2012).

The jigsaw instructional strategy is one of the learning strategies under cooperative and collaborative learning in which, the content of the lesson is subdivided into different parts of information and then given to groups of students who would later explain to each other their parts and results in the whole jigsaw puzzle to be completed (Aronson & Patnoe, 2011). The Jigsaw instructional procedure is a highly structured cooperative learning method, which was created by Aronson (Aronson, 2005; Heeden, 2013). In the application of the Jigsaw Method, the teacher introduces a topic and its subtopics. The students are then divided into 'home' groups, where they are each given a different subtopic in the group. The next step requires the students to break out of their 'home' groups to form the 'expert' groups where these students focus on one subtopic, researching and discussing it. Therefore, the students become experts on the subtopic that they have been assigned to. Following their discussion, the students from all of the 'expert' groups must return to the 'home' groups and teach their peers based on their findings and discussions. Eventually, all the members of the 'home' groups will have learnt from each expert group discussion and will have benefitted from each other.

In the Jigsaw strategy, four characteristics delineate it and contribute to its success. They are mixed ability grouping, individual accountability and responsibility, group reward and motivation, and equal opportunity for the success of every participant (Chan, 2014). In Jigsaw classrooms, the lesson to be taught is presented to the whole class which is previously divided into heterogeneous home groups (teams) consisting of four or five members; from each group, one student is sent to an expert group which masters the given sub-topic. Returning to home groups each 'expert' teaches the content to other group members. The group performance and improvement of scores of individuals are recognised. Even though the tests are conducted individually, learners are encouraged and motivated to work jointly to enhance the overall performance of the group.

Safkolam *et al*. (2023) investigated the effects of the Jigsaw Technique on Learning Achievement and Retention of Science Teacher Students in Thailand. The learning achievement of science teacher students before and after learning with the Jigsaw technique was explored using experimental research. The participants in this research consisted of 32 second-year students in the Department of General Science at Rajabhat University in southern Thailand who enrolled in the course Learning Management 1 in the first semester of the academic year 2022. The research tools consisted of the jigsaw technique lesson plan and a learning achievement test. The statistics used in

data analysis were mean standard deviation and dependent Sample t-test. The result of the learning achievement test of the science teacher students who learned by using the Jigsaw technique found that the mean score of learning achievement after learning was significantly higher than before learning at the 0.05 level. The findings suggest that the Jigsaw technique is one learning management that can improve learning achievement.

Digitised jigsaw instructional strategies on cell biology are a way of using technology to enhance the jigsaw method of teaching cell biology concepts. Cell biology is the study of the structure, function, and interactions of cells, which are the basic units of life. Cell biology concepts include topics such as cell structure, cell cycle, cell division, cell differentiation, cell signalling, cell transport, and cell metabolism. Digitised jigsaw instructional strategies on cell biology involve dividing a cell biology topic into subtopics and assigning each subtopic to a group or individual. Each group or individual then uses digital tools and resources to research, create, and present their subtopic to the rest of the class. For example, students can use online platforms, apps, or software to access information, videos, animations, simulations, quizzes, or games on their subtopic. They can then use slides, videos, podcasts or interactive games to present their subtopic to the class using a projector, a screen-sharing tool, or a video conferencing platform.

Digitised jigsaw instructional strategies on cell biology can have several benefits for students and teachers, such as:

1. Engaging students in active and collaborative learning.
2. Developing students' digital literacy and 21st-century skills.
3. Providing students with multiple sources and formats of information.
4. Enhancing students' understanding and retention of cell biology concepts.
5. Differentiating instruction and assessment according to students' needs and preferences.
6. Saving time and resources by using online materials and tools.

In digitised jigsaw strategy, involves a set of collaborative learning activities for the learning of cell biology in the Classroom using the Jigsaw-within-LAMS design pattern using canvas. The proposed digitised Jigsaw instructional strategy consisted of the following seven phases; introduction to the activity; original group creation; creation of expert groups; back to the original groups; group Report formation; group report presentation and assessment. The implementation of these phases within the context of LAMS is represented as a design. The presentation of this collaborative pattern aims at supporting a combination of synchronous and asynchronous collaboration but this pattern could be used exclusively for asynchronous collaboration by substituting the “Chat and Scribe” function with the “Forum and Scribe” function or vice versa to support exclusively synchronous collaboration.

To implement digitised jigsaw instructional strategies on cell biology in your classroom, you can follow these steps:

Choose a cell biology topic that can be divided into subtopics. For example, you can choose cell structure as a topic and divide it into subtopics such as cell membrane, cytoplasm, nucleus,

organelles, and cell wall. Assign each subtopic to a group or individual. You can either assign the subtopics randomly or based on students' interests, abilities, or preferences. Make sure each group or individual has access to a device and an internet connection. Provide each group or individual with a list of digital tools and resources that they can use to research, create, and present their subtopic. You can also provide them with some guiding questions or objectives to help them focus on the key points of their subtopic. For example, you can provide them with links to websites, videos, animations, simulations, quizzes or games that explain their subtopic. You can also suggest some tools or apps that they can use to create slides, videos, podcasts, or interactive games to present their subtopic. Give each group or individual enough time to work on their subtopic. You can monitor their progress and provide feedback and support as needed. You can also encourage them to collaborate and communicate with each other using online platforms or tools.

Arrange a time and a platform for each group or individual to present their subtopic to the rest of the class. You can use a projector, a screen-sharing tool, or a video conferencing platform to facilitate the presentations. You can also ask the audience to take notes, ask questions or give feedback to the presenters. After all the presentations are done, review and summarise the main points of the cell biology topic. You can also ask the students to reflect on what they learned and how they learned it using the digitised jigsaw instructional strategies. You can also assess their learning using quizzes, tests, projects, or portfolios.

Some benefits of using digitised jigsaw instructional strategies on cell biology are:
They engage students in active and collaborative learning. Students are more motivated and interested in learning when they have a choice and a voice in their learning process. They also learn from each other and develop social and communication skills. They develop students' digital literacy and 21st-century skills. Students learn how to use various digital tools and resources to access, create, and share information. They also learn how to evaluate, synthesise, and apply information to solve problems and make decisions. They provide students with multiple sources and formats of information. Students are exposed to different perspectives and representations of cell biology concepts. They also have more opportunities to interact with the information and deepen their understanding. They enhance students' understanding and retention of cell biology concepts. Students are more likely to remember and apply what they learn when they are actively involved in the learning process. They also have more chances to review and reinforce their learning through presentations and feedback. They differentiate instruction and assessment according to students' needs and preferences. Students can work at their own pace and level of difficulty. They can also choose the subtopics, tools, and resources that suit their learning styles and interests. They can also demonstrate their learning in different ways and formats.

Purpose of the study

1. find out the effect of digitised reverse jigsaw instructional strategy on remediating misconceptions in cell biology

among undergraduates in Ondo state;
2. determined the difference in misconceptions remediated among male and female undergraduates when taught cell biology using a digitised reverse jigsaw instructional strategy.

Research Hypotheses

$H0_1$: there is no significant difference in the number of misconceptions remediated among undergraduates taught cell biology using a digitised reverse jigsaw and those taught using conventional teaching

$H0_2$: there is no significant difference in the number of misconceptions remediated among male and female undergraduates when taught cell biology using a digitised reverse jigsaw instructional strategy

Empirical Studies on Instructional Strategy for Remediating Students' Misconceptions in Biology

Ogundare *et al*. (2020) investigated the effects of concept-mapping instructional strategy on remediating senior school students' misconceptions of ecology. A multistage sampling technique was used to select senior secondary school students offering biology from the target population. The instruments were concept mapping on ecology and basic ecological concept achievement tests. The data collected were analysed using simple percentages for research questions and chi-square statistics for testing the research hypothesis. Findings revealed that biology students held many misconceptions about ecology; also concept-mapping instructional strategy remediated just one out of every four misconceptions held by the students hence there is no significant difference in the number of misconceptions held by students in experimental and control groups.

Luwoye *et al.* (2021) investigated the influence of the demo kit on remediating misconceptions held by senior secondary schools in mitosis and meiosis in Ilorin metropolis. The quasi-experimental design of the pre-test, post-test, non-randomised, non-equivalent control group was adopted for the study. The mitosis and meiosis conception package (MMCP) was the instrument for data collection. Frequencies and chi-square were used to answer the research questions and test the null hypothesis respectively. The findings reveal that senior school biology students hold misconceptions of mitosis and meiosis before and after instruction and can be carried on to higher institutions, There is a significant difference in the number of misconceptions held by students taught using the demo kit and those taught using the conventional method.

Amelia *et al*. (2021) carried out research using e-modules to remediate misconceptions, including the development of interactive e-modules using 3D Page flip as a result, a decrease in misconceptions with the results of validation of e-modules feasible and the response of educators and students is very good. Also, using interactive e-modules based on cognitive conflicts gets a very valid or feasible result (Pratama *et al*. 2021). Another study by Verawardana and Ambiyar (2018), found a decrease in remediation of 14.26% from 60.21% before using the module, while the use of interactive multimedia decreased remediation by 0.67%.

Hamid and Haka (2021) conducted research aimed at reducing students' misconceptions using a conceptual change model assisted by the integrated Android-based Quran. The study used a quasi-experimental design with a one-group pretest-posttest design. The

research instrument was multiple-choice questions equipped with a certainty of response index (CRI) developed based on the revised Bloom taxonomy indicator. The data collection techniques used were tests (pretest and posttest). The results of the study obtained a reduction value of misconceptions in the pretest, namely understanding the concept at 47 % (moderate), misconception at 48 % (moderate) and not understanding the concept at 5 % (low). The posttest score decreased (reduced) the proportion of misconceptions to 42 % (moderate), not understanding the concept to 4 % (low), and understanding the concept to 55 % (moderate). The hypothesis testing employed was the one-sample t-test. Findings indicated that the conceptual change model (MCC) with Android-based Quran media can reduce students' misconceptions with a criterion of 0.71 (medium interval).

Retone and Prudente (2023) assessed undergraduates' misconceptions of the central dogma of molecular biology. This study developed a three-tier diagnostic test to identify misconceptions carried forward to undergraduate students enrolled in biologically related courses, leading to the development of the Central Dogma of Molecular Biology Questionnaire (CDMBQ). This study found that the CDMBQ has very good reliability (a = 0.88) and moderately positive construct validity (r = 0.4). It also revealed that the respondents have a low understanding of the central dogma (mean = 4.76), and they have acquired misconceptions about transcription, types of RNA, and translation. Lastly, perception items showed students have forgotten central dogma concepts, display confusion about the topic and maintain neutral sentiments about their science teacher as well as have neutral feelings about their understanding of the central dogma. Nonetheless, they expressed interest in studying its concepts. These results confirm the reliability and validity of the CDMBQ for assessing misconceptions surrounding the central dogma of molecular biology.

Solviana *et al*. (2024) developed a media that can be used in remediating misconceptions, namely a PJBL-based interactive e-module with a scientific approach. This research is R&D research with a development model ADDIE (Analysis, Design, Development, Implementation and Evaluation). The instrument used, a four-tier diagnostic test to find out misconceptions and an e-module validation questionnaire given to media experts, material experts and language experts to test and determine the feasibility of the e-module and response educators regarding e-modules and student questionnaires for testing limited trial and extensive trial. The data analysis technique uses descriptive quantitative. The research results show the value of expert suitability media is very decent, namely 89%, the value of material experts is very good decent, namely 90%, very decent linguist score, namely 94%, the test score try educators very worthy 89%, limited trials very decent 84% and widely tested value very feasible 80%, shows that the e-module is suitable for use. Results from the n-gain effectiveness test 71.4%, e-module PJBL-based interactive with a scientific approach is quite effective in remediating students' misconceptions about structural material and the function of plant tissue.

According to Olorundare (2014), misconceptions or words misunderstood by students can impede meaningful understanding of science thereby

standing as a barrier to study. This implies that students hold misconceptions in science subjects and this affects their scientific knowledge. Student misconceptions in cell biology are obstacles in learning biology courses and unless remediated may continue causing difficulties as students advance in their studies. Therefore there is a need to remediate the misconceptions identified in cell biology among undergraduates through a digitised jigsaw instructional strategy which contains suggested pedagogical techniques that will be used to correct students' misconceptions of biology concepts.

Researchers such as Kalu-Uche and Emeka (2018) and Safkolam *et al*. (2023) have studied the effect of jigsaw instructional strategies on students' performance in biology and science. Kalu-Uche and Emeka (2018) investigated the effect of the Jigsaw learning strategy on senior school student's academic performance in biology in Abia state. Safkolam *et al*. (2023) investigated the effects of the jigsaw technique on learning achievement and retention of science teacher students in Thailand. The findings from these studies showed that the jigsaw instructional strategy could improve the academic achievement of students in biology. However, none of these previous studies have been able to use online platforms as a means to remediate misconceptions of cell biology among undergraduates so the knowledge gap arises in the use of digitised jigsaw instructional strategies to remediate students' misconceptions and improve the academic performance of undergraduates. So this study will investigate the effect of digitised reverse jigsaw instructional strategy on remediating the misconceptions of cell Biology held by undergraduates.

METHOD

The research design for this study was a quasi-experiment of pre-test, post-test, non-equivalent and non-randomised control group design using 2x2 factorial designs. The experimental group was treated with digitised jigsaw II strategy while the control group was exposed to conventional teaching. The population of the study comprises all undergraduates offering cell biology courses in Nigerian universities. The target population for the study comprised all 200-level undergraduates offering cell biology in universities in Ondo state, Nigeria. A simple random sampling technique will be used to select 32 undergraduates across the four institutions that will participate in this study. Two research instruments were used for the collection of data and they include; the Cell Biology Conception Test (CBCT) and the Digitised Jigsaw II Instructional package (DJIP). Cell Biology Conception Test (CBCT) consists of sixty-two multiple-choice questions on cell biology. The researcher created multiple choice questions based on course objectives and content, using a digitised Jigsaws strategy on the online open-source Learning Management System, canvas, to address students' misconceptions.

The CBCT and DJIP were tested by experts at Al-Hikmah University, Ilorin, for face and content validity. The reliability of the CBCT was determined using a test-retest method at two-week intervals. The test was administered to 10 undergraduates in a non-participating university for a pilot study. After two weeks, the data was re-administered to the same group. The CBCT was used as a pre-test to assess students' understanding and misconceptions of

cell biology before exposure to treatments. The data was calculated using Cronbach Alpha and a reliability index of 0.78 was obtained. The researchers used Canvas to divide cell biology content into modules and assign students to groups. Each student was assigned to their module and studied independently on the online open learning management system. The biology lecturer guided the control group through conventional teaching methods. After four weeks, students in both experimental and control groups were post-tested to determine their understanding and misconceptions using the CBCT with reshuffled questions. Data from both groups was analysed using t-test statistics and SPSS version 26. The study aimed to explore the impact of the digitised jigsaw II strategy and conventional teaching methods on cell biology learning.

RESULTS AND DISCUSSION

The hypotheses are tested at 0.05 level of significance and the results are presented in the following tables;

$H0_1$: There is no significant difference in the number of misconceptions remediated among undergraduates taught cell biology using a digitised reverse jigsaw and those taught using conventional teaching

Table 1

Independent sample t-test of misconceptions remediated among undergraduates taught cell biology using digitised Reverse jigsaw and those taught using conventional teaching.

Groups	Number	Mean	SD	Df	Cal. T	p-value	Remark
Exper. (DRJ)	16	26.88	9.069	30	5.608	0.000	Rejected
Control group	16	10.94	6.855				

Sig. at $p < 0.05$

Table 1 revealed that the mean number of misconceptions remediated in the experimental group is 26.88 while the mean number of misconceptions remediated in the control group is 10.94. The standard deviation of the misconceptions remediated in experimental and control groups are 9.069 and 6.855 respectively. The mean indicates that students in the digitised reverse jigsaw group had a higher number of misconceptions remediated compared to those in the conventional teaching group.

Also, the independent sample t-test result shows that at degrees of freedom 30, the calculated t-value is 5.608 and the p-value of 0.000. The calculated t-value (5.608) is associated with a p-value of 0.000. The p-value of 0.002 is less than 0.05 significance level (Cal. $t = 5.608$; $p = 0.000 < 0.05$) indicating a highly significant difference in the number of misconceptions remediated between the two groups. Since the p-value is less than 0.05, the null hypothesis is rejected. This suggests that there is a significant difference in the number of misconceptions remediated between undergraduates taught using digitised reverse jigsaw and those taught using conventional teaching methods. The statistical analysis strongly indicates that the digitised reverse jigsaw method is significantly more effective in remediating misconceptions in cell biology compared to conventional teaching methods among undergraduates. The large difference in

mean values, coupled with a highly significant p-value, supports the conclusion that digitised reverse jigsaw is a superior teaching method for addressing misconceptions in biology.

$H0_2$: There is no significant difference in the number of misconceptions remediated among male and female undergraduates when taught cell biology using a digitised reverse jigsaw instructional strategy.

Table 2

Paired sample t-test of misconceptions remediated among male and female undergraduates when taught cell biology using digitised reverse jigsaw I instructional strategy.

Gender	Number	Mean	SD	Df	Cal. T	p-value	Remark
Male	9	28.89	6.864	14	1.008	0.331	Not Rejected
Female	7	24.29	11.354				

Sig. at $p < 0.05$

Table 2 revealed that the mean number of misconceptions remediated among male undergraduates is 28.89 while the mean number of misconceptions remediated among female undergraduates is 24.29. The standard deviation of the misconceptions remediated among male and female undergraduates are 6.864 and 11.354 respectively. The mean indicates that on average, male undergraduates had slightly more misconceptions remediated than female undergraduates when taught cell biology using a digitised reverse jigsaw instructional strategy**.**

The paired sample t-test result shows that at degrees of freedom 14, the calculated t-value is -1.008 and the p-value is 0.331. The calculated t-value of 1.008 is associated with a p-value of 0.331. The p-value of 0.331 is greater than the significance level of 0.05 (Cal. t = 1.008; p = 0.331 > 0.05) indicating that the difference in the number of misconceptions remediated between male and female undergraduates is not statistically significant when taught cell biology using digitised reverse jigsaw instructional strategy. Since the p-value is greater than 0.05, the null hypothesis is not rejected**.** This suggests that there is no significant difference in the number of misconceptions remediated between male and female undergraduates when taught using the digitised reverse jigsaw instructional strategy. The statistical analysis suggests that there is no significant difference in the effect of the digitised reverse jigsaw instructional strategy in remediating misconceptions in cell biology between male and female undergraduates. Gender does not significantly influence the number of misconceptions remediated when using a digitised reverse jigsaw instructional strategy.

DISCUSSION

The study revealed a statistically significant difference in the number of misconceptions remediated between undergraduates taught using the digitised reverse jigsaw instructional strategy and those taught with conventional teaching approaches. The statistical analysis strongly indicates that the digitised reverse jigsaw instructional strategy is significantly more effective in remediating misconceptions in cell biology compared to conventional teaching methods among undergraduates. The digitised reverse jigsaw strategy stands out as an effective strategy in addressing and remediating misconceptions. The finding aligned

with the finding of Amani *et al*. (2019) who reported that students taught with the use of reversed jigsaw performed better than their counterparts taught with the conventional method. However, this is in contrast to the research of Mayorga *et al*., (2020) who uncovered that reversed jigsaw was not effective in knowledge acquisition.

The reason is that the digitised reverse jigsaw strategy engages undergraduates in a deeper, more reflective learning process that directly challenges and remediates their misconceptions, unlike conventional teaching methods which may focus more on the delivery of information. Another reason for this finding could be because the digitised reverse jigsaw strategy typically involves students' first mastering content individually and then teaching it to their peers. In a digitised format, this process might be further enhanced through interactive tools, digital resources, and collaborative learning platforms. This method encourages students to critically evaluate and discuss the material, leading to better identification and correction of their own and their peers' misconceptions. The success of the digitised reverse jigsaw strategy could be due to its combination of individual accountability, peer teaching, and interactive learning, making it more effective than conventional approaches in remediating persistent misconceptions. The finding strongly indicates that the digitised reverse jigsaw instructional strategy is significantly more effective than conventional teaching methods in correcting misconceptions about cell biology among undergraduates.

Another finding revealed that there is no statistically significant difference in the number of misconceptions remediated between male and female undergraduates when taught cell biology using digitised reverse jigsaw instructional strategy. The statistical analysis suggests that there is no significant difference in the effect of the digitised reverse jigsaw instructional strategy in remediating misconceptions in cell biology between male and female undergraduates. This indicates that the strategy is equally effective for both genders in correcting misconceptions about cell biology. The digitised reverse jigsaw instructional strategy appears to work similarly well for male and female students. This means that the instructional strategy does not favour one gender over the other, ensuring that both male and female undergraduates benefit equally from the method. This finding is corroborated by the research of Jimoh et al. (2016) who revealed that gender did not contribute significantly to varying students' achievement scores. It is inconsistent with Charles-Ogan's (2014) work which found a significant difference between male and female senior school students' misconceptions using a metacognitive strategy and revealed that female students had fewer misconceptions than their male counterparts in the study.

The finding is valuable for educators as it suggests that the digitised reverse jigsaw strategy can be used effectively in diverse classroom settings without concern for gender disparities. It supports the strategy's use as an inclusive teaching tool that promotes equal learning opportunities for all students. The primary goal of the digitised reverse jigsaw strategy is to address and correct misconceptions in

cell biology. The finding indicates that the strategy successfully achieves this goal without introducing gender bias, making it a reliable method for improving students' conceptual understanding regardless of gender. This finding indicates that the digitised reverse jigsaw instructional strategy is equally effective in remediating misconceptions in cell biology for both male and female undergraduates.

CONCLUSION

The study concludes that incorporating a digitised reverse jigsaw instructional strategy into cell biology instruction will significantly improve students' understanding by helping them remediate their misconceptions. Digitised jigsaw reverse strategy is a powerful strategy that should be considered in instructional design by educators aiming to improve students' conceptual understanding by effectively remediating misconceptions. The study concludes that the digitised reverse jigsaw instructional strategy is effective in remediating misconceptions in cell biology for both male and female undergraduates. This strategy is gender-neutral, making them reliable and inclusive outfits for educators aiming to remediate misconceptions in their classrooms.

RECOMMENDATIONS

1. Lecturers should integrate digitised reverse jigsaw instructional strategy into biology instruction in other to improve undergraduates' understanding by helping them remediate their misconceptions
2. Biology textbook authors globally should incorporate digitised reverse jigsaw instructional strategy in presenting hard-to-teach and hard-to-learn biology concepts in their textbooks
3. Educational policymakers should include digitised reverse jigsaw instructional strategies in classroom activities because it is a reliable gender-neutral strategy for remediating misconceptions.

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