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Al-Hikmah Journal of Education (AJE)
Volume 12 Number 2 December, 2025
e-ISSN: 2705-2508; p-ISSN: 2384-7662

Investigating the Effect of Digitized Jigsaw II Strategy on Correcting Undergraduates' Misconceptions in Cell Biology

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ABSTRACT

The study investigated the effect of the digitized Jigsaw II instructional strategy on remediating misconceptions in Cell Biology among undergraduates in Ondo State, Nigeria. Two purposes and two hypotheses guided the study. A quasi-experiment of pre-test, post-test, non-equivalent control group design was adopted for the study. The purposive sampling technique was used to select 64 undergraduates across two universities who participated in this study. Two research instruments were used for the collection of data, and they include the Cell Biology Conception Test (CBCT) and the Digitized Jigsaw II Instructional Package (DJIP). The CBCT and DJIP were given to three experts in the Department of Biological Sciences and Department of Science Education, Al-Hikmah University, Ilorin, for face and content validity. The data collected in the pre-test and post-test of both groups was analyzed 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 digitized jigsaw II strategy and those taught using conventional teaching methods. Also, there was no significant difference in the number of misconceptions remediated between male and female students when taught cell biology using the digitized jigsaw II strategy. It is recommended that biology lecturers should adopt the digitized Jigsaw II strategy for teaching cell biology without gender-based differentiation in order to improve undergraduates' understanding and remediate their misconceptions in biology.

Keywords: Misconception, Digitized Jigsaw II Strategy, Canvas, Undergraduate, Cell Biology

INTRODUCTION

Biology is the scientific study of living organisms and their interactions with the physical environment, and it plays a critical role in human health, economic development, and environmental sustainability. Advances in biological knowledge have contributed significantly to medicine, agriculture, biotechnology, and disease control, making Biology a foundational discipline for scientific literacy and national development (Augustine, 2018; Jadhav et al., 2024). Among its many sub-disciplines, cell biology occupies a central position in the life sciences curriculum, particularly at the tertiary level, as it underpins genetics, molecular biology, physiology, growth and development (Rashid et al., 2023).

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Cell biology, also known as cytology, focuses on the structure, function, and organization of cells the basic structural and functional units of life. Mastery of cell biology concepts is essential for understanding complex biological processes and for success in advanced biological and health-related studies. However, due to the abstract and microscopic nature of cellular structures and processes, students often experience difficulty developing accurate conceptual understanding. As a result, many undergraduates harbor persistent misconceptions about cell structures, functions, and interactions, which negatively affect learning outcomes and scientific reasoning (Dorji & Zam, 2024).

Misconceptions in biology are ideas that conflict with scientifically accepted explanations and often arise from prior experiences, preconceptions, cultural beliefs, or ineffective instructional approaches (Laksana, 2016). In cell biology, such misconceptions can impede meaningful learning and remain resistant to change if not deliberately addressed. Research has shown that students' poor performance in Biology is not solely attributable to curriculum difficulty but also to instructional practices that rely heavily on teacher-centered methods, limited instructional materials, and inadequate opportunities for active learning (Abimbola, 2013; Adeoye et al., 2022; Avwiri & Okoli, 2021).

Traditional lecture-based approaches often fail to engage students actively or confront their alternative conceptions, thereby allowing misconceptions to persist. Consequently, science education researchers have advocated for learner-centered instructional strategies that promote interaction, collaboration, and conceptual change. Among these, cooperative learning has been widely recognized for enhancing academic achievement, social skills, and deeper understanding of scientific concepts (Aziz & Hossain, 2010).

The Jigsaw II instructional strategy**,** a structured form of cooperative learning, emphasizes peer teaching, positive interdependence, and individual accountability. In this approach, students become experts in specific content areas and subsequently teach their peers, fostering active engagement and deeper conceptual processing. Empirical studies have demonstrated the effectiveness of the Jigsaw II strategy in improving students' achievement and conceptual understanding in Biology and other science subjects (Chukwu & Arokoyu, 2019; Safkolam et al., 2023; Tabiolo & Rogayan, 2019). With the increasing integration of digital technologies into higher education, digitizing cooperative learning strategies offers additional opportunities to enhance learning. A digitized Jigsaw II strategy incorporates online platforms, digital resources, and interactive tools to support collaboration, visualization, and accessibility, particularly in contexts where instructional resources are limited (Duda & Adpriaydi, 2020). This approach holds promise for addressing abstract concepts in cell biology and facilitating the remediation of students' misconceptions.

Few studies have been conducted on identifying and remediating students' misconceptions in biology using learner-centered instructional strategies. Retone and Prudente (2023) assessed undergraduates' misconceptions on 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. This study found that the respondents have a low understanding of the central dogma and they have acquired misconceptions pertaining to transcription, types of RNA, and translation. Luwoye *et al*. (2021) used demo kit to remediate senior school students' misconceptions in mitosis and meiosis in

Al-Hikmah Journal of Education (AJE)
Volume 12 Number 2 December, 2025
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Ilorin. Findings revealed that Biology students held many misconceptions on cell division.

Ogundare *et al*. (2020) employed concept-mapping to remediate the misconceptions about ecology held by senior school students in Oyo. The results showed that biology students had many misconceptions about ecology, and that only one out of every four of the students' misconceptions was remediated by the concept-mapping instructional strategy.

Despite growing evidence supporting cooperative and technology-enhanced learning, limited empirical studies have examined the effectiveness of a digitized Jigsaw II strategy in correcting undergraduates' misconceptions in cell biology, particularly within tertiary institutions in Ondo state. None of these previous studies have been able to use online platform as a means to remediate misconceptions of cell biology among undergraduates so the knowledge gap arises in the use of digitized jigsaw instructional strategies to remediate students' misconceptions and improve the academic performance of undergraduates. Consequently this study investigated the effect of digitized jigsaw II instructional strategy on remediating the misconceptions of cell Biology held by undergraduates in Ondo State with the aim of contributing evidence-based insights to biology education research and instructional practice.

Purpose of the Study

The main purpose of the study is to investigate the effect of digitized jigsaws instructional strategy on remediating misconceptions in Cell Biology among undergraduates in Nigeria. Specifically, this study;

1. find out the influence of digitized jigsaw II instructional strategy on remediating misconceptions in cell biology among undergraduates in Ondo state;
2. investigated the difference in misconceptions remediated among male and female undergraduates when taught cell biology using digitized jigsaw II instructional strategy.

Research Hypothesis

$H_0$1: there is no significant difference in the number of misconceptions remediated among undergraduates taught cell biology using digitized jigsaw II and those taught using conventional teaching

$H_0$2: there is no significant difference in the number of misconceptions remediated among male and female undergraduates when taught cell biology using digitized jigsaw II instructional strategy

METHODS

The research design for this study was a quasi-experiment of pre-test, post-test, non-equivalent control group design. Experimental group was treated with digitized jigsaw II strategy while the control group will be exposed to conventional teaching. The population of the study comprises all undergraduates offering cell biology course in universities in Ondo state. The target population for the study comprised all 200 level undergraduates offering cell biology in universities in Ondo state. Purposive sampling technique was used to select 64 undergraduates across the two institutions that participated in this study.

Al-Hikmah Journal of Education (AJE)
Volume 12 Number 2 December, 2025
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Two research instruments were used for the collection of data and they include; Cell Biology Conception Test (CBCT) and Digitized Jigsaw II Instructional package (DJIP). Cell Biology Conception Test (CBCT) consists of thirty two multiple choice questions on cell biology. The multiple choice questions were designed by the researcher based on the objectives and content of the course. The options consisted of correct answer and students' misconceptions. This digitized Jigsaw II strategy was carried out on online open source Learning Management System called canvas. The CBCT and DJIP were given to three experts in the Department of Biological Sciences and Department of Science Education, Al-Hikmah University, Ilorin for face and content validity. The CBCT was administered to 10 undergraduates in a non-participating but equivalent university for the pilot study. The data was calculated using Cronbach Alpha and a reliability index of 0.78 was obtained.

The CBCT was administered as pre-test to determine students' level of understanding and misconceptions in cell biology prior to their exposure to treatments. The experimental group was treated with digitized Jigsaw II instructional strategy targeting misconceptions already identified through the pre-test result of CBCT. The researcher downloaded, registered canvas and added the students through their email address. The researcher divides cell biology contents into different modules and uploads them. The subtopics were divided into seven modules and assigns individual students into group. Each student in the home group was assigned to their module and they downloaded the contents and study it independently. This was done completely on canvas online open learning management system. The biology lecturer (serving as research assistants) guides the control group through the use of conventional teaching which was used by undergraduates to learn cell biology. After four weeks of exposing students to treatment using digitized jigsaw II strategy and conventional teaching method for learning cell biology, students in the experimental and control groups were post tested to determine their understanding and the misconceptions held by undergraduates using the CBCT but with reshuffled questions. The data collected in the pre-test and post-test of both groups was analyzed using t-test statistics through Statistical Package for Social Sciences (SPSS) version 23.

RESULTS

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

H_{01}: there is no significant difference in the number of misconceptions remediated among undergraduates taught cell biology using digitized jigsaw II and those taught using conventional teaching.

Table 1: Independent sample t-test of misconceptions remediated among undergraduates taught cell biology using digitized jigsaw II and those taught using conventional teaching.

Groups	Number	Mean	SD	Df	Cal. T	p-value	Remark
Exper. (DJII)	32	21.38	9.892	62	3.469	0.002	Rejected
Control group	32	10.94	6.855				

Sig. at $p < 0.05$

Al-Hikmah Journal of Education (AJE)
Volume 12 Number 2 December, 2025
e-ISSN: 2705-2508; p-ISSN: 2384-7662

Table 1 reveals that the mean number of misconceptions remediated in digitized jigsaw II group is 21.38 while mean number of misconceptions remediated in conventional teaching group is 10.94. The standard deviation of the misconceptions remediated in experimental and control groups are 9.892 and 6.855 respectively. The mean shows that on average, students taught using digitized jigsaw II had more misconceptions remediated than those taught using conventional teaching, with a noticeably higher mean in the digitized jigsaw II group.

Also the independent sample t-test result shows that at degrees of freedom 62, the calculated t-value is 3.469 and p-value of 0.002. The calculated t-value (3.469) is associated with a p-value of 0.002. The p-value of 0.002 which is less than 0.05 significance level (Cal. t = 3.469; p = 0.002 <0.05) indicating that the difference in the number of misconceptions remediated between the two groups is statistically significant. Since the p-value is less than 0.05, the null hypothesis is rejected. This indicates that there is a significant difference in the number of misconceptions remediated between undergraduates taught using digitized jigsaw II and those taught using conventional teaching methods. The statistical analysis suggests that the use of digitized jigsaw II significantly increased the remediation of misconceptions in cell biology compared to conventional teaching methods among undergraduates. Therefore, digitized jigsaw II is more effective in remediating misconceptions than the conventional teaching method

$H_0$2: there is no significant difference in the number of misconceptions remediated among male and female undergraduates when taught cell biology using digitized jigsaw II instructional strategy

Table 2 Independent sample t-test of misconceptions remediated among male and female undergraduates when taught cell biology using digitized jigsaw II instructional strategy

Gender	Number	Mean	SD	Df	Cal. T	p-value	Remark
Male	20	19.30	8.832	30	-1.090	0.294	Not Rejected
Female	12	24.83	11.409				

Sig. at p < 0.05

Table 2 revealed that the mean number of misconceptions remediated among male undergraduates is 19.30 while mean number of misconceptions remediated among female undergraduates is 24.83. The standard deviation of the misconceptions remediated among male and female undergraduates are 8.832 and 11.409 respectively. The mean indicates that on average, male undergraduates had slightly more misconceptions remediated than female undergraduates when taught cell biology using digitized jigsaw II instructional strategy.

t-test result shows that at degrees of freedom 30, the calculated t-value is -1.090 and p-value is 0.294. The calculated t-value of -1.090 is associated with a p-value of 0.294. The p-value of 0.294 is greater than the significance level of 0.05 (Cal. t = -1.090; p = 0.294 > 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 digitized jigsaw II instructional strategy. Since the p-value is greater than 0.05, the null hypothesis is not rejected. 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

Al-Hikmah Journal of Education (AJE)
Volume 12 Number 2 December, 2025
e-ISSN: 2705-2508; p-ISSN: 2384-7662

male and female undergraduates when taught using the digitized jigsaw II instructional strategy.

The statistical analysis suggests that there is no significant difference in the effectiveness of the digitized jigsaw II 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 digitized jigsaw II instructional strategy.

DISCUSSION

This study found a statistically significant difference in the number of misconceptions remediated between students taught using the digitized jigsaw II strategy and those taught using conventional teaching methods. The observed significant difference suggests that the digitized Jigsaw II strategy provides a more effective learning environment for addressing undergraduates' misconceptions in cell biology than traditional teaching methods. This effectiveness may be attributed to its collaborative and interactive structure, which promotes deeper conceptual understanding and active engagement among learners. This finding is consistent with Solviana et al., (2024) who found that an 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. It also corroborated with Yusuf et al. (2012) findings who revealed that computer supported STAD and Jigsaw instructional strategies enhance student performance. The digitized jigsaw II approach involves more interactive, focused, and student-centered learning, which may help students confront and revise their misconceptions. Digitized jigsaw II strategy could include specific activities or discussions that directly address common misconceptions, thereby leading to more effective remediation. The finding indicates that the digitized jigsaw II instructional strategy is significantly more effective than conventional teaching methods in remediating misconceptions in cell biology among undergraduates. The finding suggests that incorporating digitized jigsaw II into cell biology instruction can significantly improve students' understanding by helping them overcome their misconceptions. This makes it a valuable tool for educators looking to enhance conceptual clarity and deepen students' comprehension of the subject matter.

The study also found no statistically significant difference in the number of misconceptions remediated between male and female students when taught cell biology using the digitized jigsaw II strategy. The absence of a significant gender difference suggests that the digitized Jigsaw II strategy provides an inclusive learning environment in which both male and female undergraduates benefit equally in correcting misconceptions in cell biology. This is corroborated by the research of Jiyah (2016) who found that there is no significant difference in the achievement of male and female biology students when use hands-on with minds-on strategy to learn cell division. It is also consistent with the research of Jimoh, et al., (2016) who revealed that gender did not contribute significantly to varying students' achievement scores.

The finding is important for educators because it suggests that digitized jigsaw II can be confidently used in mixed-gender classrooms without worrying about gender-related differences in learning outcomes. This supports the use digitized jigsaw II as an inclusive and equitable instructional strategy. The primary focus of this finding is on the remediation of misconceptions in cell biology.

Al-Hikmah Journal of Education (AJE)
Volume 12 Number 2 December, 2025
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The fact that the strategy is equally effective for both male and female students highlights its robustness and versatility in achieving this educational goal. It shows that the method can be applied broadly to remediate misconceptions without introducing gender bias. This finding indicates that the digitized jigsaw II instructional strategy is equally effective in remediating misconceptions in cell biology among both male and female undergraduates. The strategy's gender-neutral impact makes it a valuable and inclusive tool for educators seeking to improve students' understanding of complex concepts.

CONCLUSION

The integration of a digitized Jigsaw II instructional strategy presents a promising pathway for addressing the critical challenges of persistent misconceptions in cell biology among undergraduate learners. This approach also enhances conceptual understanding by fostering collaborative learning through digital platforms. The findings of this study underscore the potential of cooperative, technology-enhanced pedagogies to transform biology education in resource-constrained environments. This strategy is gender-neutral, making them reliable and inclusive outfits for educators aiming to remediate misconceptions in their classrooms. The digitized Jigsaw II model exemplifies how thoughtful instructional design can empower learners and correct misconceptions to improve the quality of science education.

RECOMMENDATIONS

1. Teacher training programmes and professional development workshops should emphasize the use of digitized collaborative strategies such as Jigsaw II to promote effective misconception correction among diverse learner populations.
2. Biology Lecturers should adopt the digitized Jigsaw II strategy for teaching cell biology without gender-based differentiation**.** Since gender does not significantly influence its effectiveness in remediating misconceptions, lecturers and curriculum planners should integrate this strategy as a gender-inclusive and equitable instructional approach in undergraduate biology classrooms

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