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Teaching and Learning of Genetics Using Concept Maps: An Experimental Study Among Midwifery Students in Ghana

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Abstract

Students' understanding of genetics and its associated mechanisms can be a difficult task. Though there are several instructional approaches to enhance the teaching and learning of genetics among medical, nursing, midwifery, and other allied health students in Ghana, little is known about the use of concept mapping as a teaching strategy. This study aimed to investigate the effect of using concept maps to enhance the teaching and learning of genetics among midwifery students in Ghana. We conducted an experimental study using the pre-test/post-test control group design. Fifty-one (51) midwifery students (females) in Ghana were voluntarily recruited and randomly assigned into either experimental or control groups using a 'balloting method.' In the pretest phase, the groups were first administered a Genetics Achievement Test (GAT) to measure their understanding of basic genetic concepts. The experimental and control groups received two (2)-weeks of lessons in genetics using concept mapping and lecture methods respectively during the intervention phase. Following the intervention phase, a posttest (GAT) was administered a week after the intervention to determine whether concept-mapping as a teaching strategy significantly improved the learning and achievement of students. Data analysis was conducted using JASP software (Version 0.14.1). Results showed that there was no significant difference in GAT scores between the groups during the pretest phase, (t = 0.763, df = 45, ρ = 0.194, d = 0.214). However, the experiment group performed better in the GAT than the control group, (t = 9.402, df = 45, ρ < .001, d = 2.634). In conclusion, the concept mapping teaching strategy is recommended

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as a useful approach for the teaching and learning of genetics. Teachers can blend this method with the traditional lecture approach to improve learning outcomes among nursing students.

Keywords: concept maps, genetics, Ghana, JASP Software, lecture method, midwifery students, teaching and learning.

1. Introduction

Genetics is fundamental to biological and other applied sciences in the field of health sciences and agriculture (Winchester, 2018). Genetics is complex and its abstract nature can make both teachers and students misconceive it as a difficult scientific concept to teach and learn (Etobro, Banjoko, 2017; Gusmalini, Wulandari, 2020; Kantahan et al., 2020; Osman et al., 2017). For example, Etobro and Banjoko (2017) observed that seventy-five percent (75 %) of pre-service Nigerian biology teachers who participated in their study held several delusions regarding genetics. Among these false beliefs, most participants in the study attributed it to the nonrepresentational methods of teaching genetic concepts. Consequently, it is imperative to find other methods that can enhance the teaching and learning of genetics and its associated mechanisms (Gusmalini, Wulandari, 2020; Etobro, Banjoko, 2017).

Globally, the concept mapping method of teaching is becoming a popular instructional strategy for nursing and midwifery (Jaafarpour et al., 2016). The concept mapping method allows the teacher to organise educational concepts realistically in visual forms. These visual illustrations bring out the relations among concepts in the form of flowcharts, tables, T-charts, and Venn Diagrams (Safdar et al., 2012). Though studies on the practicality of concept mapping for teaching nursing and midwifery students had existed for decades, its mechanism and application had not been fully explored (All et al., 1997; All, Havens, 2003).

In a quasi-experimental study in a university in central Taiwan, it was indicated that concept mapping strategy improved the critical thinking of students who took a semester course in medical-surgical nursing (Lee et al., 2013). The effectiveness of concept mapping as a teaching strategy for students had been attributed to students' ability to think critically about lessons taught in nursing and midwifery (Yue et al., 2017).

Apart from its advantage of enhancing critical thinking among nursing and midwifery students, the effectiveness of concept mapping had been attributed to its ability to aid student nurses to grasp several concepts during lessons (Akinsanya, Williams, 2004). As noted in a study by Akinsanya and Williams (2004), concept mapping offered students the opportunity to engage in meaningful and stimulating learning experiences due to the visual nature of presentations. Notwithstanding the increasing popularity of concept mapping in global nursing and midwifery education, there is a paucity of data within the sub-Saharan Africa context. Evidence from the study by John et al. (2019) involving sixty (60) high school biology students in Nigeria suggested concept mapping as an effective method for teaching genetics. Their experimental study reported that students who were taught using concept mapping performed better on Genetics Achievement Test (GAT) than the group that received lessons using the demonstration method.

Aside from this Nigerian example, the practicality of using concept mapping to teach Ghanaian nursing and midwifery students is yet to be fully investigated experimentally. Therefore, the purpose of this study was to examine the effectiveness of concept mapping as a strategy for teaching and learning genetics among midwifery students in Ghana. This study compared concept mapping to the traditional lecture approach of instruction. The traditional lecture method is known for its practicality in teaching a large number of students, introducing a new topic in which students have little previous knowledge, communicating basic facts, terminologies or promoting initial understanding of the concepts (Chifwa, 2015).

3. Methods

Research Design

A true experimental study was conducted using a pre-test/post-test control group design. The experimental and quasi-experimental designs are known to be useful when measuring the effectiveness of methods of teaching (John et al., 2019) or differences among approaches; for example – the traditional lecture approach of instruction with the flipped classroom among student nurses (Dehghanzadeh, Jafaraghaee, 2018).

Sample and Sampling Procedure

We randomly sampled fifty-one (51) midwifery students in Ghana who were willing to participate in the study. These participants were assigned to the experimental and control groups through a 'balloting method'. The control and experimental groups were made up of 25 and 26 students respectively. Both experimental and control groups were all females class in their second year where they had previously taken courses in genetics, anatomy, and physiology. These student midwives were all having varying intellectual abilities with ages ranging between 18 and 24 years old.

Instrument for Data Collection

A twenty (20) multiple-choice item GAT was adapted from the nursing and midwifery curriculum and other existing studies (John et al., 2019; Yang et al., 2018). Items in this test focused on the significance of chromosomes in heredity, dominant and recessive characteristics, genotypic and phenotypic characteristics, and application of genetics in medicine. Test-retest of the GAT among nursing students in a two (2) week interval gave a reliability coefficient (r) of 0.70.

Procedure

Following all the prescribed ethical procedures required for human studies, official institutional permission and informed consent from participants were obtained before the start of the study.

The experiment consisted of the following phases:

Pretest Phase: All participants in both experimental and control groups were administered the GAT to evaluate their understanding of genetics before the intervention phase.

Intervention phase: Four (4) lessons on selected genetic phenomena were given by the first author using either concept mapping for the experimental group or the traditional lecture method for the control groups respectively for two (2) weeks. The same instructor (first author) was used to teach both groups to ensure that they receive equivalent educational content and instructor quality. Educational content included the genetic terminologies (genotype, phenotype, dominant and recessive traits), mutation, sex determination, conditions associated with genetic transfer: (Klinefelter syndrome, Down syndrome), and genetic counselling. The objectives of the lesson, procedures, and instructional purposes were also explained to the students in each lesson. After each lesson, students in both groups were given assignments and allowed to ask questions.

In the experimental group, educational materials were taught using PowerPoint slides with pictorial drawings of the concepts showing linkages among the concepts. This approach is based on the constructivist view of learning where learners take an active role in learning to ensure meaningful learning (Yue et al., 2017). In addition to the PowerPoint slides, lessons delivered via concept mapping also included constructing linkage diagrams on the board to facilitate the understanding of the concept. Participants were also asked to construct their concept maps using markers on the writing board.

The control group was taught using the traditional lecture method. Educational materials were presented as a lecture to them by the first author during alternate sessions. Educational content was simply presented through PowerPoint slides at each session.

Post-intervention: A week following the intervention, the GAT was again administered as a posttest to both groups. The scores from each group were scored, entered, and screened for data analysis.

Data Analysis

The scores from the pretest and posttest phases were analysed using the JASP software Version 0.14.1 (JASP Team, 2020). Following initial screening for normality (Shapiro-Wilk), outliers, and missing data, the means, standard deviation, frequencies, and percentages of both groups were calculated. The differences between their scores on GAT in the pretest and posttest phases were analysed to Independent t-test statistics at $\rho<0.05$.

4. Results and Discussion

The analysis showed that there was no statistically significant difference between the GAT scores of the experimental and control groups before the intervention, (t = 0.763, df = 45, ρ = 0.194, d = 0.214). As a result, the mean±standard deviation GAT scores during the pretest indicated that the experimental group (11.154 ±0.925) and the control group (10.960±0.889) had a

similar level of knowledge on the concept of genetics before the commencement of the treatment (See Figure 1).

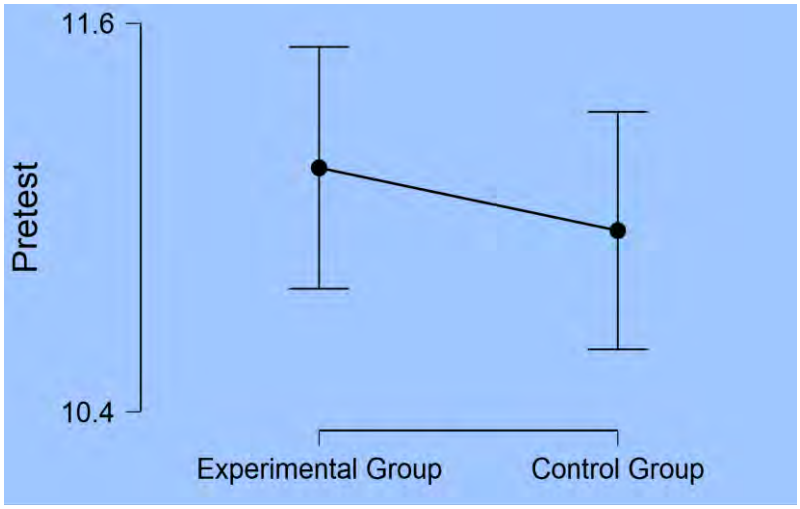

Fig. 1. Pretest Scores on GAT

Furthermore, there was a significant improvement of performance in GAT among the experiment group compared to the control group, (t = 9.402, df = 45, ρ < .001, d = 2.634). As shown in Figure 2, the mean±standard deviation GAT scores during the posttest indicated that the experimental group (16.192±0.849) performed better than the control group (13.120±1.424) after being exposed to the concept mapping method of teaching.

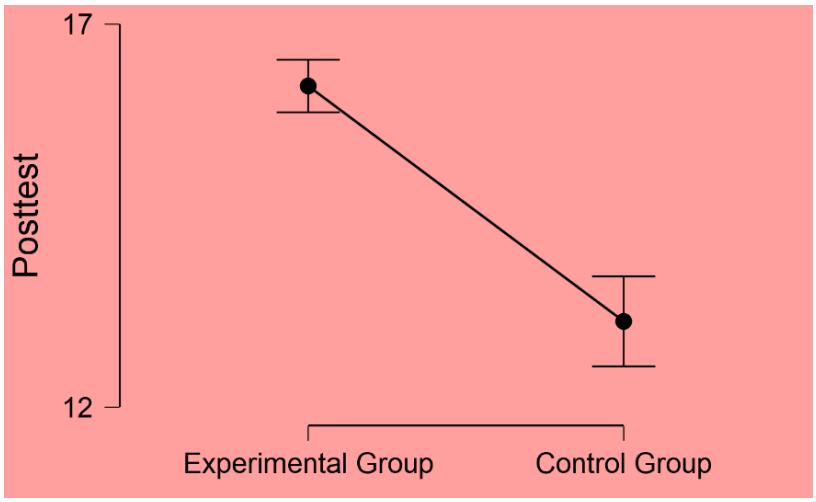

Fig. 2. Posttest Scores on GAT

Results in this present study show that concept mapping is a more effective method in teaching genetic concepts than the traditional lecturer method. The data from this study provided support for the potency of the concept-mapping technique in bringing about the learning of genetics in a meaningful manner. The experimental group who were taught using concept mapping was found to achieve significantly better than their control group counterparts after the intervention. This finding is supported by a study by John et al. (2019) who provided experimental evidence that concept mapping improved the learning of genetics among Nigerian participants. Akeju et al. (2012) attributed an improvement in students' performance due to students' ability to easily store and recall learned materials after being taught via concept mapping. They believed that concept mapping positively affects the learning attitude of students.

It is clear from this present study's results that there was some increase in the mean±standard deviation of the pretest/posttest scores of the lecture method, (10.960±0.889) < (13.120±1.424). The lecture method is one of the commonly used methods of teaching (French, Kennedy, 2017). Its teacher-centered learning focus may promote rote learning in some instances due to students' passive role of failing to form linkages between previous and present knowledge. Petty (2009) reiterated that lecture as a teaching method is useful for the explanation of content by a teacher although it may result in passive assimilation by the students. The performance of the students may be attributed to their inability to connect ideas about genetic concepts and terminologies as rote or passive learning.

Additionally, the lecture method is not suitable for slow learners and pupils who have language problems. It can be boring because the students are not actively involved in the lesson and the concentration span for students is short (Davar, 2012). Studies have shown that blending teaching methods improve learning and achievement rather than the traditional teacher-centered method of teaching (Akeju et al., 2012; Dehghanzadeh, Jafaraghaee, 2018; French, Kennedy, 2017; John et al., 2019). According to Chifwa (2015), the lecture method promotes an initial understanding of concepts and principles. Notwithstanding the limitations of the traditional lecture methods, the lecture method has some value in pedagogical circles although additional creative approaches are needed (French, Kennedy, 2017).

5. Conclusion and Recommendations

The primary focus of this study was to ascertain whether meaningful learning of genetics will be promoted and enhanced by the use of concept mapping. When teachers use concept mapping teaching strategies to teach biological phenomena, students perform significantly better than their counterparts who are taught using the traditional lecture method of teaching. Although the spiral curriculum been practiced in Ghana aims at teaching genetics concepts from basic to complex as learners progress in their education, learners are not able to familiarize themselves with the terms and mechanisms due to the approaches they and the abstract nature of genetics and associated misconceptions. The study recommends that teachers of clinical nursing/midwifery programmes and other health-related schools utilize concept mapping as part of their blended teaching methods to suit enhance meaningful learning of genetic phenomena.

6. Acknowledgements

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7. Conflict of interest

We hereby declare that we have no conflict of interest in the conduct of this study or declaration of results.

References

Akeju et al., 2012 – *Akeju, O.O.S., Rotimi, O.C., Kenni, A.M.* (2012). Teaching with concept mapping instructional strategy in Nigeria secondary schools. *International Journal of Physics & Chemistry Education*. 4(SI): 13-19.

Akinsanya, Williams, 2004 – *Akinsanya, C., Williams, M.* (2004). Concept mapping for meaningful learning. *Nurse Education Today*. 24(1): 41-46.

All et al., 2003 – *All, A.C., Huycke, L.I., Fisher, M.J.* (2003). Instructional tools for nursing education: Concept maps. *Nursing Education Perspectives*. 24(6): 311-317.

All, Havens, 1997 – *All, A.C., Havens, R.L.* (1997). Cognitive/concept mapping: a teaching strategy for nursing. *Journal of Advanced Nursing*. 25(6): 1210-1219.

Chifwa, 2015 – *Chifwa, J.* (2015). Teaching of genetics in selected secondary schools in Kitwe district, Zambia. (Unpublished Master's Dissertation). Zambia.

Davar, 2012 – *Davar, M.* (2012). Teaching of science. New Delhi: PHI Learning Private Limited.

Dehghanzadeh, Jafaraghaee, 2018 – *Dehghanzadeh, S., Jafaraghaee, F.* (2018). Comparing the effects of traditional lecture and flipped classroom on nursing students' critical thinking disposition: A quasi-experimental study. *Nurse Education Today*. 71: 151-156.

Etobro, Banjoko, 2017 – *Etobro, A.B., Banjoko, S.O.* (2017). Misconceptions of genetics concepts among pre-service teachers. *Global Journal of Educational Research*. 16(2): 121-128.

French, Kennedy, 2017 – *French, S., Kennedy, G.* (2017). Reassessing the value of university lectures. *Teaching in Higher Education*. 22(6): 639-654.

Gusmalini, Wulandari, 2020 – *Gusmalini, A., Wulandari, S.* (2020, October). Identification of misconceptions and causes of student misconceptions on genetics concept with CRI method. *Journal of Physics: Conference Series*. IOP Publishing. 1655(1): 012053.

Jaafarpour et al., 2016 – *Jaafarpour, M., Aazami, S., Mozafari, M.* (2016). Does concept mapping enhance learning outcome of nursing students? *Nurse Education Today*. 36: 129-132.

JASP Team, 2020 – JASP Team (2020). JASP (Version 0.14.1) [Computer software]. [Electronic resource]. URL: https://jasp-stats.org/

John et al., 2019 – *John, F., Sani, A. N., Ranccas, B. M., Maskawa, B. U.* (2019). Effects of concept mapping and demonstration method on senior secondary two biology students' achievement in genetics in Jos North, Plateau State. *KIU Journal of Humanities*. 3(4): 177-182.

Kantahan et al., 2020 – *Kantahan, S., Junpeng, P., Punturat, S., Tang, K. N., Gochyyev, P., Wilson, M.* (2020). Designing and verifying a tool for diagnosing scientific misconceptions in genetics topic. *International Journal of Evaluation and Research in Education*. 9(3): 564-571.

Lee et al., 2013 – *Lee, W., Chiang, C. H., Liao, I. C., Lee, M. L., Chen, S. L., Liang, T.* (2013). The longitudinal effect of concept map teaching on critical thinking of nursing students. *Nurse education today*. 33(10): 1219-1223.

Osman et al., 2017 – *Osman, E., BouJaoude, S., Hamdan, H.* (2017). An investigation of Lebanese G7-12 students' misconceptions and difficulties in genetics and their genetics literacy. *International Journal of Science and Mathematics Education*. 15(7): 1257-1280.

Petty, 2009 – *Petty, G.* (2009). Teaching today: A practical guide. *New Delhi Proceedings of the 39th Annual Conference of STA3*, 133-136.

Safdar et al., 2012 – *Safdar, M., Hussain, A., Shah, I., Rifat, Q.* (2012). Concept maps: An instructional tool to facilitate meaningful learning. *European Journal of Educational Research*. 1(1): 55-64.

Winchester, 2018 – *Winchester, A.M.* (2018). Genetics. In Encyclopedia Britannica. [Electronic resource]. URL: https://www.britannica.com/science/genetics

Yang et al., 2018 – *Yang, C., Jen, C.H., Chang, C. Y., Yeh, T.K.* (2018). Comparison of animation and static-picture-based instruction: Effects on performance and cognitive load for learning genetics. *Journal of Educational Technology & Society*. 21(4): 1-11.

Yue et al., 2017 – *Yue, M., Zhang, M., Zhang, C., Jin, C.* (2017). The effectiveness of concept mapping on development of critical thinking in nursing education: A systematic review and meta-analysis. *Nurse Education Today*. 52: 87-94.