



Comparative Assessment of Woodwork and ... Nasiru, Z., Et. al. (2025)

Comparative assessment of Wood work and Paper Approach on Self Efficacy in Biological Model Development among Pre-Service Teachers in Zamfara State, Nigeria

NASIRU, Zayyanu¹

Zayyanunasiru24@gmail.com

08034560483

BELLO, Shamsudeen¹

Shamsudeen.bello@ssu.edu.ng

08032890327

UMAR, Aisha¹

Aishaumar258@gmail.com

08108431997

OKORO R. U.¹

Robertokoro55@gmail.com

08035630866

¹Department of Science Education, Sokoto State University, Sokoto.

Abstract

Biology education in Nigeria faces significant challenges, including inadequate resources and a shortage of skilled educators, often limiting the use of crucial biological models for visual learning. Many pre-service teachers lack the requisite skills and confidence to create effective models. This study investigated the Comparative assessment of Wood work and Paper Approach on Self Efficacy in Biological Model Development among Pre-Service Teachers in Zamfara State, Nigeria. A quasi-experimental design was employed, and 84 pre-service biology teachers were sampled from selected tertiary institutions. Participants were assigned to two groups; an experimental group trained in woodwork approach, and a control group trained in paper moulding practice in model creation. Data were collected using validated researcher designed instruments: the Self-Efficacy Questionnaire for Woodwork and paper instructional strategies in Biological Model Development (BMDSQ). Reliability indices were established at 0.89. Three research questions guided the study, and three null hypotheses were tested at a 0.05 level of significance. The study found NCE III pre-service biology teachers demonstrated significantly higher self-efficacy in developing models using both woodwork and paper instructional strategies compared to their NCE II counterparts, confirming that higher training correlates with improved self-efficacy. Additionally, the wood work approach significantly enhanced self-efficacy more than the paper approach. Recommendations suggest integrating practical skills like woodwork into teacher training programmes to encourage pre-service teachers' confidence and improve the quality of biology education in resource limited settings.

Key words: Woodwork, Paper Approach, pre-service teachers, biological models, self-efficacy.

Introduction

Biology teaching is central to science education, enabling learners to understand the natural world (Tatka et al., 2023). However, in Nigeria, challenges such as inadequate infrastructure, limited resources, and a shortage of skilled teachers hinder effective instruction (Sokoto State Ministry of Education, 2020). To enhance comprehension, teaching methods must be engaging and hands-on, with biological models serving as critical tools for illustrating complex concepts (Clark et al., 2020; Joyner & Goel, 2015). Models aid in visualizing abstract biological structures and processes, yet many Nigerian biology teachers lack the skills and confidence to construct them effectively (Yilmaz et al. 2016). The ability to design and interpret models enhances students' learning and critical thinking (Tatka et al., 2023), but teachers often struggle due to insufficient training (Farhana &



Comparative Assessment of Woodwork and ... Nasiru, Z., Et. al. (2025)

Chowdhury, 2019). Comprehensive models such as wooden structures of plant cells require technical competencies like carpentry (Yilmaz et al. (2016). Incorporating wood work into science education fosters creativity, problem solving, and craftsmanship (Al-husaini & Amayreh, 2021). It bridges the gap between theory and practice, improving students' retention and self-efficacy (Menon & Azam, 2021). The paper approach remains popular for its accessibility and effectiveness in developing visual and diagrammatic skills (Adeoye, 2020). However, its limitations in durability and depth underscore the need for additional hands-on skills (Adeoye, 2020). Pre-service teachers, as future science educators, must possess both the self-efficacy and technical skills necessary to create accurate, engaging biological models (Hetherington & Mead, 2024). Woodwork enhances essential competencies such as measurement, design, and spatial reasoning (Al-husaini & Amayreh, 2021), while high self-efficacy boosts instructional effectiveness (Martin et al., 2020).

Statement of the Research Problem

The absence of specialized training for constructing teaching aids especially models during pre-service teacher education programs creates a significant barrier to effectively incorporate any skill in biology education. In biology education, the use of teaching aids such as biological models is essential for enhancing visualization, simplifying complex concepts, and improving students' understanding. However, in many Nigerian teacher education programs, the predominant improvisation method employed by pre-service biology teachers is paper practice, due to its affordability and availability of materials.

While paper practice has provided a simple and accessible option, it is often limited by poor durability, lack of precision, and insufficient resemblance to real biological structures. These shortcomings restrict its effectiveness in classroom teaching and fail to adequately develop the psychomotor competence of pre-service teachers. Moreover, reliance on paper practice does not sufficiently boost the confidence and self-efficacy of trainees, as the models produced are due to damage and less effective for long term instructional use. Woodwork offers the potential to produce more durable, realistic, and functional models while simultaneously engaging pre-service teachers in hands on skill acquisition. This approach is anticipated to enhance their skills by strengthening measurement, cutting, joining, and finishing skills, while also improving their self-efficacy through the successful creation of lasting models. If this study is not conducted, pre-service biology teachers in Zamfara State would likely continue relying on paper moulding practice as the dominant method of improvisation, despite its limitations in producing durable and realistic biological models. As a result, many pre-service biology teachers would remain with low self-efficacy in their skill to develop models, thereby reducing their willingness to improvise and use teaching aids in the classroom. This breach in training not only slow down the professional development and self-efficacy of pre-service biology teacher's but it also potentially limits the quality of science education provided to students in the state. The continued dependence on less effective methods would also weaken the quality of biology education, as students would have fewer opportunities to visualize abstract concepts through well-constructed models. Introducing woodwork practice into biological model development presents an opportunity to address these gaps. This study therefore sought to investigate on the Comparative assessment of Wood work and Paper Approach on Self-Efficacy in Biological Model Development among Pre-Service Teachers in Zamfara State, Nigeria

Objectives of The Study

The main objective of this study is to compare the Comparative assessment of Wood work and Paper Approach on Self Efficacy in Biological Model Development among Pre-Service Teachers To achieve this the following objectives were set to find out:



Comparative Assessment of Woodwork and ... Nasiru, Z., Et. al. (2025)

1. The difference between self-efficacy of pre-service biology teachers' exposed to woodwork and those expose to paper approach on development of biological models in Zamfara State, Nigeria.
2. The difference between self-efficacy of NCE II and NCE III pre-service biology teachers' exposed to woodwork on development of biological models in Zamfara State, Nigeria.
3. The difference between self-efficacy of NCE II and NCE III pre-service biology teachers' exposed to paper approach on development of biological models in Zamfara State, Nigeria.

Hypothesis

1. There is no significant difference in self-efficacy between pre-service biology teachers' exposed to the woodwork and those exposed to the paper Approach on development of biological models in Zamfara State, Nigeria.
2. There is no significant difference between the self-efficacy of NCE II and NCE III pre-service biology teachers exposed to woodwork on development of biological models in Zamfara State, Nigeria.
3. There is no significant difference between the self-efficacy of NCE II and NCE III pre-service biology teachers exposed to paper Approach on development of biological models in Zamfara State, Nigeria.

Methodology

This study employed pre-test and post-test Quasi-experimental design, which is appropriate as it involves creating two groups, an experimental group receiving woodwork training and a control group receiving the paper Approach training. Both groups were pre-tested and post-tested on their self efficacy to develop biological models. Following the interventions (woodwork training) for the experimental group, both groups will be post-tested to measure the influence of the training. The population of this study comprises of 107 NCE II and NCE III pre-service biology teachers in the two colleges of education that enroll teacher education programs in Zamfara State which are Federal College of Education Technical, Gusau (FCET GUSAU) and College of Education, Maru (COE MARU). A sample size of 84 is chosen using Raosoft research advisor 2025. The sampling technique used was purposive sampling technique to choose NCE II and NCE III preservice biology teachers in the second and third year of their training because NCE II have not gone for teaching practice but preparing to and NCE III they have gone for teaching practice which make them to be conversant with learners and teaching aids which means they most have used one or two industrial made biological models in teaching biological concepts. Hence the need to use them in this study and guide them on how to develop these models by themselves using woodwork as a skill. Thus, simple random sampling was used to choose the main participants of the study in which a numbered list of the preservice biology teachers was written on sheets of papers and placed in a contained shuffle and are picked randomly by the participants. One research instrument; Titled Biological Model Development (BMDSQ). The Self-Efficacy Questionnaire was developed and used for data collection. It was divided into two sections sought for demographic information of the participants and section B comprises 16-item that assesses an individual's self-efficacy in creating biological models. Respondents rate their level of agreement with each statement on a 5-point Likert scale, ranging from Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4) to Strongly Agree (5). The instrument aims to evaluate participants' self-efficacy in woodwork and paper Approach to develop biological models, integrating these skills with teaching methods and enhancing student learning. To ensure the validity of the instrument four experts were involved, three of which are from the department of science education Sokoto State University and one from the woodwork and joinery department of Government Technical College (GTC) Farfaru Sokoto State. A draft copy of the instrument was served



Comparative Assessment of Woodwork and ... Nasiru, Z., Et. al. (2025)

to them for face, content and criterion validity. Their feedbacks are used to calculate the Content Validity Index (CVI). The validity index for the instrument is greater than the standard index required for any instrument to be valid for academic research, the CVI obtained for the Self-Efficacy Questionnaire for Wood Work strategy and Paper Approach in Biological Model Development (BMDSQ) is 0.77. To ensure that the instruments are reliable a pilot study was conducted and the instruments are pilot tested to a non-sampled institution within the population and administered to 20 education biology preservice teachers. Their responses were put into SPSS software to compute the Cronbach's alpha value for each of the instruments, which is 0.89. The method of data collection was a general introduction to the management of the selected institutions. The researcher with the help of two trained assistants started by administering a pre-test instrument which is Biological Model Development Self Efficacy Questionnaire then the experimental was trained on how to make physical biological models such as flower and plant leaf using woodwork approach while control groups were trained using paper approach. The training lasted for six weeks. Lastly, the Biological Model Development Self Efficacy Questionnaire was administered for the second time as a Pos- test. The method of data analysis used to test the null hypotheses, one, two and three is Man Whitney U test and median. All the analyses were conducted using Statistical Package for Social Sciences (SPSS).

Presentation of Results

Null hypothesis 1

There is no significant difference in self-efficacy between pre-service biology teachers exposed to the woodwork and those exposed to the paper Approach on development of biological models in Zamfara State, Nigeria

Table 1: Difference in self-efficacy between woodwork and paper moulding practice

Group	N	Median Rank	Mean Rank	Sum of mean Rank	Mean Difference	U	Z	P-Value	Decision
Woodwork	44	53.50	61.44	105.44					
Paper Moulding Practice	40	47.00	21.69	61.69	6.50	47.5	65.34	.000	Rejected

Source: field work 2025

$\alpha=0.05$

The result of Mann-Whitney U test shows the self-efficacy of pre-service biology teachers exposed to woodwork and those exposed to the paper Approach. Participants in the woodwork group has a higher median rank of 53.50, with a mean rank of 61.44 and a sum of mean ranks of 105.44, while those in the paper Approach group has a lower median rank of 47.00, a mean rank of 21.69, and a sum of mean ranks of 61.69. The mean difference between the two groups was 6.50, in favour of the woodwork group. The results revealed a statistically significant difference between the two groups, $U = 47.5$, $Z = 65.34$, $p = .000$. Therefore, the null hypothesis is rejected. This finding indicates that pre-service biology teachers exposed to woodwork demonstrated significantly higher self-efficacy in developing biological models than those taught using the paper Approach.

Null hypothesis 2

There is no significant difference between the self-efficacy of NCE II and NCE III pre-service biology teachers exposed to woodwork on development of biological models in Zamfara State, Nigeria.

Table 2: Difference in self-efficacy between NCE II and NCE III woodwork experimental group in developing models.



Comparative Assessment of Woodwork and ... Nasiru, Z., Et. al. (2025)

Group	N	Median Rank	Mean Rank	Sum of Ranks	Mean Difference	U	Z	p-value	Decision
NCE II	24	45.00	12.65	32.65					
					10.50	437.0	18.17	.000	Rejected
NCE III	20	55.50	30.71	50.71					

Source: field work 2025

$\alpha=0.05$

The results showed that the NCE III group has a higher mean rank of 30.71 and a median rank of 55.50, compared to the NCE II group, which has a mean rank of 12.65 and a median rank of 45.00. The sum of ranks was 50.71 for NCE III and 32.65 for NCE II, with a mean difference of 10.50. The test yielded a U value of 437.0, a Z score of 18.17, and a p-value of .000. Since the p-value is less than the significance level of .05, the null hypothesis was rejected. This indicates a statistically significant difference in self-efficacy between the two groups. Specifically, NCE III pre-service teachers demonstrated significantly higher self-efficacy in developing biological models using woodwork than their NCE II counterparts. The finding suggests that the level of training positively influences self-efficacy among pre-service biology teachers.

Null hypothesis 3

There is no significant difference between the self-efficacy of NCE II and NCE III pre-service biology teachers' exposed to paper Approach on development of biological models in Zamfara State, Nigeria.

Table 3: Difference in self-efficacy between NCE II and NCE III in paper moulding practice control group on developing models.

Group	N	Median Rank	Mean Rank	Sum of Ranks	Mean Difference	U	Z	p-value	Decision
NCE II	22	41.00	10.50	30.50					
					4.50	320.0	25.31	.000	Rejected
NCE III	18	45.50	28.50	52.50					

Source: field work 2025

$\alpha=0.05$

The analysis results show a statistically significant difference between the two groups, $U = 320.00$, $Z = 25.31$, $p = .000$, indicating that the null hypothesis should be rejected. NCE III pre-service teachers have a higher median rank of 45.50 and a mean rank of 28.50, while NCE II teachers have a median rank of 41.00 and a mean rank of 10.50. The mean difference between the groups was 4.50. These findings suggest that NCE III pre-service biology teachers demonstrated significantly higher self-efficacy in developing biological models using the paper Approach compared to their NCE II counterparts. The result implies that a higher level of training is associated with improved self-efficacy, even when using traditional instructional methods.

Discussion of Findings

The findings related to hypothesis one revealed a statistically significant and positive difference in self-efficacy between pre-service biology teachers who were exposed to the woodwork and those who underwent training through the paper Approach method. This suggests that the woodwork based instructional model was more effective in enhancing students' self-belief to develop biological models. The outcome supports the conclusions drawn by Adeoye et al. (2022) and Abdon-Liwanag (2023),



Comparative Assessment of Woodwork and ... Nasiru, Z., Et. al. (2025)

who observed that learning strategies involving tactile and interactive experiences significantly enhance learners' engagement and comprehension. When students interact physically with learning materials, as in the case of constructing models through woodwork, they are more likely to develop a deeper understanding of the subject matter. This enhanced understanding contributes to a stronger belief in their capacity to complete similar tasks independently, which is a core component of self-efficacy. Moreover, the woodwork inherently provides a learning environment that encourages risk taking, experimentation learning. According to Harun et al. (2019), the development of self-efficacy is closely attached to motivational factors and individual personality traits. When pre-service teachers engage in constructive, hands-on tasks, they are not only developing practical skills but are also nurturing intrinsic motivation and a belief in their potential as effective educators. The active nature of the woodwork method fosters a sense of accomplishment and agency, which can be particularly powerful for pre-service teachers still forming their professional identity. Therefore, the significant improvement in self-efficacy observed in this study can be attributed to both the experiential nature of the woodwork method and its capacity to promote meaningful psychological engagement among learners.

The findings of hypothesis two indicate a significant interaction between the levels of training in relation to self-efficacy in developing biological models. Specifically, pre-service biology teachers at the NCE III level who were exposed to the woodwork approach demonstrated significantly higher self-efficacy scores than their NCEII. This suggests that the impact of the woodwork instructional method on self-efficacy and level is not uniform across academic levels; rather, it becomes more pronounced as students advances in their training. The woodwork method, with its emphasis on active engagement, problem solving, and hands on practice, appears to better support the developmental needs and learning maturity of higher level trainees, such as those in NCE III. This finding aligns with the work of Harun et al. (2019), who emphasized that self-efficacy, motivation, and teaching effectiveness are deeply influenced by both the method of instruction and the learner's level of training or experience. As students progress in their education, they may be more prepared to take advantage of complex, constructive learning strategies that demand higher order thinking and practical application. The woodwork method, which requires learners to design, measure, construct, and evaluate physical models, directly nurtures these skills and builds the confidence needed to replicate and teach biological concepts effectively. It also underscores the importance of integrating practical, skill based instructional methods such as woodwork model making into biology education, particularly at advanced levels of teacher training. Doing so can strengthen pre-service teachers' self-belief to create and use instructional models, which is vital for effective science teaching. Enhanced self-efficacy not only boosts a teacher's willingness to engage learners with diverse instructional tools but also improves classroom performance, adaptability, and innovation in teaching practices. For pre-service biology teachers, especially those in their final year of training, the findings highlight the value of experiential learning methods that go beyond theoretical instruction. As they prepare to enter the teaching profession, exposure to authentic, hands-on activities like woodwork based modeling can empower them with the skills, confidence, and creativity needed to deliver engaging and effective biology lessons.

The findings from hypothesis three showed that NCE III pre-service biology teachers demonstrated significantly higher self-efficacy in developing biological models using the paper Approach when compared to their NCE II counterparts. This observation strongly supports the foundational work of



Comparative Assessment of Woodwork and ... Nasiru, Z., Et. al. (2025)

Harun et al. (2019), who underscored the critical link between self-efficacy and teacher motivation and effectiveness, suggesting that a more comprehensive background in pedagogy naturally fosters greater confidence in instructional tasks. It further aligns with the research by Yıldız, EmreÜrünArıcı (2021), which indicated that pre-service science teachers' self-efficacy beliefs are positively influenced by their training and preparedness. This significant difference is attributable to the NCE III pre-service biology teachers' more advanced level of training, extended practical experience, and broader academic exposure within the Nigerian educational system, all of which contribute to a more thoughtful confidence in applying established, conventional model making techniques. On the contrary, these findings precisely diverge from the primary emphasis found in studies such as Molino-Magtolis (2013) and Abdon-Liwanag (2023). While Molino-Magtolis demonstrated the effectiveness of model making in enhancing student understanding, and Abdon-Liwanag highlighted the positive impact of 3D models on student learning, neither explicitly glance into the pre-service teacher's self-efficacy in the process of constructing these models, particularly examining how it varies with differing levels of professional training. This differing focus indicates a crucial distinguishing factor of the current study, which zeroes in on the foundational confidence and practical readiness of educators themselves, providing insights into the human element behind instructional material development.,

Conclusion

The findings of this study conclude that the used woodwork instructional approach is more effective in enhancing self-efficacy to develop biological models among pre-service biology teachers in Zamfara State, Nigeria. The study's results support the notion that hands-on activities and applied learning experiences can improve learning outcomes and self-efficacy. The level of study of pre-service biology teachers influences their ability and self-efficacy to develop biological models. This highlights the importance of considering the level of training in instructional design.

Recommendations

1. Educational policy makers should support the integration of hands-on activities and applied learning experiences into teacher education programs.
2. Teachers of tertiary institutions should incorporate hands-on activities and applied learning experiences, such as woodwork, into their curriculum to enhance self-efficacy and ability to develop biological models among pre-service biology teachers in the institutions.
3. Tertiary institutions should consider the level of training of pre-service biology teachers by providing resources and materials necessary at each level during the teacher training programme.

Acknowledgements

All words of praises are due to Allah whose mercy makes this great work possible, peace and blessing of Allah be upon His noble and final messenger his families, companions and all those that follow them to the Resurrection Day. After that, this work would not have been possible without the collective efforts and invaluable contributions of numerous individuals from its commencement to the end. My sincere gratitude due to my esteemed supervisors, Dr. Shamsudeen Bello, Dr. Okoro, R.U. and Dr. Aisha Umar, whose expert guidance, mentorship, and patience helped shape this research into its present form. To all my lecturers and mentors, whose knowledge, wisdom, and experience have shaped my academic growth and development. Dr. Sadiq Shehu, Dean of Students' Affairs Sokoto State University, Sokoto, I have to appreciate you; your support and guidance have been invaluable to me during my time at the university. To those entire academic mentors: Dr. Hadiza Ahmad Gusau (H.O.D.) science education, Prof. N. I Tambuwaal, Dr. M.N Hassan, Dr. Usman Galadima and all other academic



Comparative Assessment of Woodwork and ... Nasiru, Z., Et. al. (2025)

mentors within the faculty of education and postgraduate school Sokoto State University whose mentorship, guidance and encouragement shape and ease the campus life through this academic voyage. Sincerest appreciations to my parents Engr. Nasiru Abdullahi and Safiya Usman, whose parental love, support, and sacrifices have been a constant source of inspiration throughout my academic journey. To my beloved wife Zainab Hanisu, whose love, encouragement, patience and understanding have been a rock-solid foundation for me throughout this research journey. I also sincerely acknowledge the efforts of all authors whose works I cited in this research, whose contributions to knowledge have enriched my understanding and informed my research. To all lovers and promoters of knowledge across the universe, whose passion for learning and pursuit of wisdom continue to inspire and motivate me. Thank you all for your contributions, support, and encouragement, May Allah reward all of you abundantly.

References

- Abdon-Liwanag, B. (2023). The Influence of 3-D Model Biological Systems in Understanding Cellular Diversity. *International Multidisciplinary Research Journal*, 4(4), 85–95. <https://doi.org/10.54476/ioer-imrj/009169>
- Adeoye, G. A. (2020). *Effects of Modelling Clay and Demonstration Kit on Senior School Students' Performance In Cell Division In Omu-Aran, Nigeria*. University of Ilorin, Ilorin, Nigeria.
- Al-husaini, A. S. A., &Amayreh, E. A. (2021). The Effectiveness of a Strategy Based on the Concepts of a Growth Mindset for Teaching Carpentry and Decoration in Developing Practical Vocational Skills and Imaginative Thinking. *Canadian Center of Science and Education*, 17(4), 1–9. <https://doi.org/10.5539/ass.v17n4p1>
- Clark, C. A. C., Helikar, T., &Dauer, J. (2020). Simulating a computational biological model, rather than reading, elicits changes in brain activity during biological reasoning. *CBE Life Sciences Education*, 19(3), 1–14. <https://doi.org/10.1187/cbe.19-11-0237>
- Farhana, Z., & Chowdhury, S. A. (2019). Use of ICT by Biology Teachers in the Secondary Schools : Bangladesh Use of ICT by Biology Teachers in the Secondary Schools : *Bangladesh Perspective*. January. <https://doi.org/10.7176/JCSD>
- Harun, I. Y., Made Putrawan, I., &Miarsyah, M. (2019). Biological teachers' motivation based on personality and self efficacy. *International Journal of Engineering Technologies and Management Research*, 6(6), 92–100. <https://doi.org/10.5281/zenodo.3266120>
- Hetherington, L., & Mead, S. (2024). Models and modelling in science teaching. *Learning to Teach Science in the Secondary School*, 142–154. <https://doi.org/10.4324/9781003110187-12>
- Ibrahim, S. A., Ibrahim, A., Ya, S., &Abdullahi, S. A. (2019). Improvisation in Teaching and Learning Biology in Senior Secondary Schools : Prospects and Challenges. *International Journal of Scientific Research in Multidisciplinary Studies*, 5(11), 33–36.
- Joyner, D. A., &Goel, A. K. (2015). Improving inquiry-driven modeling in science education through interaction with intelligent tutoring agents. *International Conference on Intelligent User Interfaces, Proceedings IUI, 2015-January(March 2015)*, 5–16. <https://doi.org/10.1145/2678025.2701398>



www.zijstemfugusau.com.ng
des@fugusau.edu.ng

DOI: <https://doi.org/10.64348/zije.2025128>

Comparative Assessment of Woodwork and ... Nasiru, Z., Et. al. (2025)

- Martin, D. A., McMaster, N., Carey, M. D., Martin, D. A., McMaster, N., & Course, M. D. C. (2020). Course design features influencing preservice teachers' self-efficacy beliefs in their ability to support students' use of ICT. *Journal of Digital Learning in Teacher Education*, 36(4), 221–236. <https://doi.org/10.1080/21532974.2020.1781000>
- Menon, D., & Azam, S. (2021). Investigating Preservice Teachers' Science Teaching Self-Efficacy: An Analysis of Reflective Practices. *International Journal of Science and Mathematics Education*, 19(8), 1587–1607. <https://doi.org/10.1007/s10763-020-10131-4>
- Molino-Magtolis, J. (2023). The Use of Model Making in Teaching Human Organ Systems. *JPAIR Multidisciplinary Research*, 11(1), 36–48. <https://doi.org/10.7719/jpair.v11i1.197>
- Sokoto State Ministry of Education. (2020). *Annual education performance report: Challenges and strategies in science education*. Sokoto State Government Press.
- Tatka, L. T., Smith, L. P., Hellerstein, J. L., & Sauro, H. M. (2023). Adapting modeling and simulation credibility standards to computational systems biology. *Journal of Translational Medicine*, 5, 1–13. <https://doi.org/10.1186/s12967-023-04290-5>
- Yıldız, Emre Ürün Arıcı, N. (2021). Yıldız, E. & Ürün Arıcı, N. (2021). An investigation of pre-service Science teachers' self-efficacy beliefs towards teaching and their teaching skills. *International Online Journal of Education and Teaching (IOJET)*, 8(2), 588-603. AN, 8.
- Yilmaz, M., Güneş, P., & Katircioğlu, H. T. (2016). Examination of the teacher self-efficacy of pre-service biology and science teachers in terms of different variables. *Journal of Turkish Science Education*, 13(1), 45–54. <https://doi.org/10.12973/tused.10156a>