An Interactive Nursing Knowledge System Based on Artificial Intelligence and Its Implications for Neonatal Care Management

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Nowadays, people are paying greater attention to the concept of childcare, and the healthy development of children is humanity’s hope for the future. The newborn stage is the most critical stage of a child’s development, and learning and mastering neonatal care is the first important lesson for parents. To meet the needs of today’s learners and to break the traditional teaching model, this paper develops a set of interactive newborn nursing knowledge system that composes the content of trivial nursing knowledge, reconstructs the knowledge structure system, and provides new teaching methods such as text browsing, 3D animation presentation, picture presentation, video presentation, interactive games, and tests for newborns. Text browsing, 3D animation, image demonstration, video demonstration, and interactive games and tests, among other new teaching methods, give a new teaching mode and method for neonatal nursing education. The study included 158 infants from local hospital. The study was divided into two groups, each with 80 cases: a control group (conventional care) and a study group (quality care management). The outcomes were contrasted and compared. The results revealed that the study group had a lower incidence of nursing defects than the control group, and the difference was statistically significant ($P < 0.05$); the study group had a lower incidence of diseases than the control group, and the difference was statistically significant ($P < 0.05$). The study goes over the complete process of incorporating the instructional display into the interactive newborn care knowledge system. Multimedia techniques and applications were researched throughout the design and production process in order to blend intrinsic knowledge material with digital technology to produce new educational ideas.

1. Introduction

The initial 28 days are extremely important and vulnerable in an infant’s life, and it accounts for almost 47% of the fatal occurrences below the age of five. These deaths are usually caused due to intrapartum asphyxia, preterm births, birth defects, and various other infections. The primary target of sustainable development goals (SDGs) is to reduce such deaths to a minimum of 12 deaths out of 1000 lives by 2030. Hence, there is a dire need of the use of advanced technologies like artificial intelligence that would enable interactive neonatal care management [1, 2].

Nowadays, science and technology have permeated all areas of human progress and development, and with the popular use of computers, the age of information technology has seen digitization presented as a primary feature [3]. Digitization can be understood as the use of digital technology, computer programmes, and other means to edit pictures, audio and video files, etc. [4]. It includes digital images, interactive media, virtual reality, new media art, etc. In the context of the digital age, the use of digital teaching and learning has facilitated the teaching of a wide range of disciplines and has embodied the significance of an innovative revolution in teaching and learning [3].

Children are the hope for the future of mankind and the continuation of human life. Health is the most basic human requirement and one of the most important social goals, and it is the primary responsibility of families and society to care for the healthy growth of children [5]. The first stage of a child’s growth after leaving the mother’s body is the neonatal stage, which is defined as the period from birth to 28 days after birth [6]. The neonatal period is a time when
physiological functions are not yet well developed, and the ability to adapt to the external environment is poor, especially as newborns need to undergo a period of adjustment before they can adapt to the extrauterine environment [7]. Under normal circumstances, babies and mothers leave the hospital around 3 days for normal births and 7 days for caesarean sections. Home care is therefore crucial to the development of the newborn period. It is understood that many families have varying levels of knowledge about newborn feeding, environmental knowledge, and skin care [8].

Neonatal care is an important component of obstetric care. Neonates are physically poor, have immature organs and tissues, are at high risk of care, and are unable to speak, requiring close supervision by caregivers [9]. Failure to identify nursing risks in clinical practice may increase the risk of nursing deficits and increase the efficiency of illnesses such as jaundice and infection. In addition, some mothers are less involved in the care of their newborns, resulting in less knowledge of care and less ability to care for them, a phenomenon that is more common in first-time mothers. Newborns are less resilient to the outside world and require delicate care, not only from nursing staff but also from family members, to ensure that the newborn is well cared for after discharge from hospital [10]. With the development of modern medicine, it is difficult to meet the current requirements of conventional care. Quality nursing management takes the patient as the object to deepen the content of nursing care comprehensively and improve the quality of nursing care, which is affirmed by nurses, physicians, and patients in the clinic [11]. This study applies quality nursing management and observes its nursing effect, which is reported as follows. Compared with adults, newborns have poorer physical quality, immature body regulation centers, and poor resistance to the outside world. Therefore, the quality of care has a great impact on the safety of care. A number of studies have confirmed that the quality of care is an important factor in the health of patients, and as a special group, it is particularly important to improve the quality of care [12].

The shortcomings of routine care are the passivity of the nursing staff, their lack of independence, and the lack of family involvement. There are certain risks associated with the care of newborns in routine care, and families are inevitably overwhelmed by their lack of nursing knowledge and unskilled nursing skills after discharge [13]. As people become more aware of medical care and have stricter requirements for nursing services, routine care cannot meet the needs of patients and can lead to medical disputes if improper care leads to defects [13].

Most of the neonatal care management programs are face-to-face courses relevant to pediatric advanced life support, emergency obstetrics and newborn care, pediatric emergency triage, and admission care. These training programs have proven to be quite successful in improving knowledge levels of the frontline health workers (FLHWs) thereby enhancing their clinical knowledge, skill retention, team work, working memory, and decision-making. But these face-to-face training programs are often costly for junior clinicians, nurses, and FLHWs especially in rural areas who work under enormous service pressures. Hence, a need for an interactive smart AI-based nursing knowledge system for neonatal care is required to render quality care to the infants.

In conclusion, quality care management in neonatal care is a valuable approach to preventing nursing defects and reducing the risk of neonatal morbidity.

2. Related Works

Digital technology is profoundly affecting the global economy, the world of science and technology, education, and other areas of scope. Foreign research and application in this area are relatively early [14]. Some developed countries have used the results of electronic technology-based research in the field of education, and education information technology has made a new breakthrough in the direction of modern multimedia technology development [15]. The United States has been researching multimedia teaching since the 1960s, focusing on the application of computer education in primary and secondary schools. In Japan, the use of advanced technology has been promoted since 1990 when it was proposed to equip all schools with multimedia hardware and software equipment and require teachers to teach with multimedia technology [16].

However, in response to the state of foreign research related to this topic, I found through my research of information related to the teaching resource pathways in neonatal nursing knowledge that there are very user-friendly advanced technology use products designed specifically for neonates, as well as books, videos, websites, and domestic neonatal nursing dissemination knowledge that are taught in the same way. A search of the App Store for iPhone revealed a selection of software with English text and teaching content on baby care [17].

There is very little information on how to systematically and comprehensively understand how to care for newborns. Of course, this is not representative of the current situation of using digital technology for newborn care knowledge abroad, but perhaps at least it illustrates the point that these applications basically achieve a commonality, namely, interactivity, fun, and autonomy [18, 19]. Due to limited search resources, not many teaching resources have been found that are specifically designed to teach neonatal care in a comprehensive and systematic way using digital technology, so not much can be reflected in the technical analysis [20, 21].

3. Materials and Methods

3.1. General Information. 158 cases of newborns in our hospital were selected for the study. The cases were randomly divided into control group having study group of 80 cases each. Inclusion criteria are as follows: (1) singleton, (2) normal fetal heartbeat in newborns, (3) no cephalopelvic disproportion in prenatal examination, (4) vaginal delivery, and (5) family members signed the informed consent form. Exclusion criteria are as follows: (1) inadequate function of vital organs in the newborn and (2) combined systemic immune system diseases. There were 30 male and 49 female...
infants in the control group, aged 3-15 d (mean 6.37 ± 2.45 d). There were 31 male and 48 female infants in the study group, aged 3-16 d (mean 6.80 ± 2.41 d). The difference in basic information between the groups was not significant (P > 0.05).

3.2. Methods. The control group underwent routine care, carrying out nursing activities according to the work of the neonatal ward, closely monitoring the neonatal signs, performing feeding and umbilical care, etc., and the families carried out routine obstetric education. The study group was given quality nursing management: (1) Position care: closely monitor the position of the newborn, help the newborn to change position, and alternate the placement of flat, prone, and side lying positions. Choose comfortable and soft materials for newborn bedding to avoid injury. Raise the head of the bed 15° in the supine position and place a towel under the shoulder to keep the shoulder at the same level as the external auditory canal. In the prone position, the head of the bed is raised, keeping the lower limbs, abdomen, chest, and head in a three-step position. In the lateral position, a cloth is rolled into a bird’s nest shape, a sponge is used as a base pad, a soft face is made into a wrap, and a water pillow is placed on the child’s head and neck. The position care management is strengthened by changing the position every 2 h to prevent pressure injuries. (2) Trust support: we admit sick newborns to our unit. Newborns are hospitalized without their mothers and have little contact with the mother, so mothers are often worried about the condition of their newborns after delivery. Nursing staff need to explain the working system of our neonatal ward to the family to gain their trust and understanding. (3) Eating care: conduct health education to educate families about the advantages of breastfeeding, actively encourage breastfeeding education, provide guidance on breastfeeding practices, and correct posture during breastfeeding, newborn positioning, and breastfeeding techniques. Breastfeeding is carried out to ensure that the newborn gets enough nutrients to promote its growth and development. Observe the newborn’s bowel movements 12 hours after birth, the volume and color of the bowel movements, and massage the abdomen to promote the elimination of faces. Record the amount of urine, observe the color of the urine, wash the baby promptly after urination and defecation, dry the buttocks after washing, and put on a good nappy. If the baby has red buttocks, allow the buttocks to dry naturally, apply buttock cream, and put on a nappy. (4) Umbilical cord care: observe the condition of the umbilical cord before it falls off. Wrap the umbilical cord within 24 hours of birth and open the gauze after 24 hours to promote the drying and falling off of the umbilical cord. Wash your hands and pinch up the umbilical cord. Dip a cotton swab in 75% alcohol and wipe around the root of the umbilical cord to clean the secretions and blood, twice a day. Do not cover the umbilical cord when wearing nappies to avoid contamination by urine. The umbilical cord often exudes secretions after it falls off. Wipe it with a cotton swab dipped in 75% alcohol, cover the cord with sterile gauze, and avoid bathing until the wound has healed. (5) Detail care: keep the newborn’s bed linen tidy, the ward air good, the temperature of the warmer appropriate, strengthen care in the morning and evening, patch the newborn’s navel and skin on time, and change nappies regularly to avoid hip redness. Strengthen nursing care during feeding of newborns to prevent choking and vomiting of milk, etc. (6) Disease care: pay close attention to changes in the child’s body.

| Group            | n  | Fall | Falling bed | Delayed inspection | Improper medication | Incidence of nursing defect events |
|------------------|----|------|-------------|--------------------|---------------------|-----------------------------------|
| Research group   | 80 | 0    | 0           | 1                  | 0                   | 1                                 |
| Control group    | 80 | 1    | 1           | 4                  | 2                   | 9                                 |
| x² value         |    | 1.06 | 1.06        | 1.86               | 2.03                | 5.77                              |
| P value          |    | 0.32 | 0.32        | 0.17               | 0.16                | 0.02                              |

| Group            | n  | Hip red | Jaundice | Eczema | Skin infection | Disease incidence |
|------------------|----|---------|----------|--------|----------------|-------------------|
| Research group   | 80 | 1       | 0        | 1      | 0              | 2                 |
| Control group    | 80 | 3       | 2        | 2      | 2              | 10                |
| x² value         |    | 1.03    | 0.07     | 0.34   | 2.03           | 4.79              |
| P value          |    | 0.31    | 0.16     | 0.56   | 0.16           | 0.03              |
temperature, skin condition, and consciousness during care; keep the skin dry and actively prevent jaundice and eczema. Open the milk early to promote timely elimination of meconium and avoid the occurrence of breastfeeding jaundice. Keep the air in the neonatal ward fresh, take protective measures when family members visit, and decline visits from sick people. Health education: actively educate family members on the advantages of family participation in newborn care. Preach on the advantages of breastfeeding and breastfeeding counsellor guidance methods and techniques. Health education booklets are produced on matters such as cord disinfection, bathing, and dressing, while nursing staff give one-to-one demonstrations at the bedside and provide hands-on guidance to families on how to do this. Regular talks are organized on knowledge related to neonatal care, combined with pictures and videos to improve families’ understanding. In order to provide careful nursing guidance outside the hospital, the nursing staff set up a WeChat group and sends tweets to the group on matters such as diet, bathing, and management of daily life, so as to answer their questions and inform them of vaccination matters in a timely manner. Simulation-based education (SBE) is originally implemented in healthcare labs using manikins and at the bedside involving actual patients. The use of SBE is huge in terms of rendering clinical realism and transferability to real-time clinical practice. In the present day and age, this SBE can be delivered on desktop computers and smartphone to ensure better service incorporating human-centered design (HCD), design thinking, and educational theories. This would enable clinical users to obtain optimum quality neonatal knowledge at any time.

Also, to ensure scalability of the neonatal knowledge management system post deployment, a continuous professional development (CPD) point would be awarded to the healthcare users and medical practitioners. This would help to bridge the knowledge and performance gap ensuring that the healthcare providers render latest, scientific, and safe care to the patients. This CPD would act as an incentive mechanism motivating healthcare providers to use the application.

The proposed interactive neonatal knowledge management system would include three educational theories, namely, spaced repetition, retrieval practice, and deliberate practice. If repetitive and spaced practice is done of the acquired knowledge, its decline is reduced and information gets retained for a longer time in the memory. Also if there is frequent and spaced review of the learned material, the retaining of the information in human memory is also enhanced. The act of deliberate practice, feedback as part of retrieval practice helps to improve learning capability.

3.3. Results. Incidence of nursing defects in the study group was lower than that in the control group, and the difference between the two groups was statistically significant ($P < 0.05$) (see Table 1).

The incidence of disease was lower in the study group, and the difference between the two groups was statistically significant ($P < 0.05$) (see Table 2).

4. Interaction Design for This Article

4.1. Production of 2D Graphic Material. Adobe’s Photoshop and Illustrator software are the main tools used in this system to create 2D graphic materials. “Illustrator” is vector graphics software, and since Illustrator is easier to use than typesetting, Illustrator is used in this system to design and layout the cover interface, secondary pages, and navigation.
bars. The design and layout of the secondary pages and the navigation bar are shown in Figures 1 and 2.

4.2. Adjustment of the Photo Material for the Picture Display

(1) Open the Illustrator file in Photoshop; set the size to 2048*1536 pixels according to the final platform application requirements of the system; cut the cover, secondary interface, navigation bar, interactive buttons, etc. layer by layer; and store them as png with a transparent background, taking the cover as an example as shown in Figure 3.

The above cut pictures will be built into folders according to the corresponding content and named to prepare for the pretechnical realisation of the program.

(2) According to the needs of the teaching content of neonatal care, the photos taken will be adjusted and processed [22]. Use Photoshop to open the selected photos and make keying and curve adjustment one by one, as shown in Figure 4.

The main reason for snapping the images to a transparent bottom is to be able to display the teaching content clearly, and the layout has been carefully designed to make the application simple, clear, and easy to use for the user, as shown in Figure 5.

All finished images on the page will be stored in png format with a transparent background. A total of 9 small images and 9 large images will be stored as photo material.

The system would be initially subjected to internal testing in the form of alpha testing being performed by small set of team members. This would enable identification of bugs, fixing of the same and refinement of the system. In the next phase, participatory testing in the form of beta testing would be performed. This would be done by nursing students who would be using the application in real-time. A second round of beta testing would be performed to ensure stability and usability of the application.
The system would be developed using the agile development process, preferably the “scrum” method emphasizing on collaborative team effort. To ensure the resources are assigned tasks appropriately, the roles of the team member would be clearly defined and communicated. The users would be involved very early as part of codesign, development, and implementation cycles. A common software tool would be used for task allocation, communication, and review of performance so that various platforms could be integrated together.

5. Discussion

The teaching content in the interactive neonatal care knowledge system is composed of three content modules: knowledge explanation, three-dimensional demonstration, and interactive test, each of which lists a number of specific knowledge points involved. Under the interactive system model, the entire content structure is reasonably constructed and designed according to rigorous teaching objectives, and the text, pictures, animation, and music materials involved in the neonatal care knowledge system are combined into a complete knowledge system structure, clearly showing the key elements of each knowledge element. A new teaching content system structure is reasonably constructed to give users a comprehensive knowledge of the basics of neonatal nursing [23–25].

In the current teaching resources for neonatal nursing knowledge, as there are many and varied learning pathways
and trivial and numerous knowledge points, multimedia technology is used to teach all the knowledge content involved in a centralized and integrated systematic way to enhance the learners’ grasp of the knowledge points. In accordance with the degree of difficulty of the knowledge modules, several teaching formats have been designed, including simple textual expressions, 3D animated presentations, and interactive game tests. The standard knowledge and actions are systematically provided in terms of basic care and difficult care, allowing users to learn in different ways, making the whole learning process clear and easy to understand, improving learning efficiency, and achieving a quick and accurate grasp of knowledge points [26–28].

6. Conclusions

The teaching system for neonatal care is medically rigorous and scientifically methodical and flexible in its delivery. Due to the growing trend towards “humanistic design” and the stressful nature of modern life, it is particularly important to be able to learn easily and freely, comprehensively and effectively, and intuitively and easily accessible. This paper examines a system with an interactive teaching model that lies between popular science and educational materials. The system uses 3D animated simulations that allow the learner to view from the front, side, back, and 360 degrees, so that movements that are difficult to understand and master can be learned effectively and repeatedly. There is no need to spend a lot of energy and time listening to lectures, breaking the traditional learning model, without any space or time constraints [29–32].

Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] United Nations Inter-Agency Group for Child Mortality Estimation, UN IGME2020. https://data.unicef.org/resources/levels-and-trends-in-child-mortality/.
[2] United Nations, “Targets and indicators for SDG 3,” 2020. https://sdgs.un.org/goals/goal3.
[3] K. Cresswell, M. Callaghan, S. Khan, Z. Sheikh, H. Mozaffar, and A. Sheikh, "Investigating the use of data-driven artificial intelligence in computerised decision support systems for health and social care: a systematic review,” Health Informatics Journal, vol. 26, no. 3, pp. 2138–2147, 2020.
[4] R. Amarasingham, R. E. Patzer, M. Huesch, N. Q. Nguyen, and B. Xie, "Implementing electronic health care predictive analytics: considerations and challenges,” Health Affairs, vol. 33, no. 7, pp. 1148–1154, 2014.
[5] T. Saheb, T. Saheb, and D. O. Carpenter, "Mapping research strands of ethics of artificial intelligence in healthcare: a bibliometric and content analysis,” Computers in Biology and Medicine, vol. 135, p. 104660, 2021.
[6] J. P. Campbell, P. Singh, T. K. Redd et al., “Applications of artificial intelligence for retinopathy of prematurity screening,” Pediatrics, vol. 147, no. 3, p. e2020016618, 2021.
[7] D. J. Mollura, M. P. Culp, E. Pollack et al., "Artificial intelligence in low- and middle-income countries: innovating global health radiology,” Radiology, vol. 297, no. 3, pp. 513–520, 2020.
[8] A. S. Adly, A. S. Adly, and M. S. Adly, "Approaches based on artificial intelligence and the Internet of Intelligent Things to prevent the spread of COVID-19: scoping review,” Journal of Medical Internet Research, vol. 22, no. 8, article e19104, 2020.
[9] S. Zare, Z. Meidani, M. Ouhadian et al., “Identification of data elements for blood gas analysis dataset: a base for developing registries and artificial intelligence-based systems,” BMC Health Services Research, vol. 22, no. 1, pp. 317–320, 2022.
[10] L. Yan and W. Liu, "Garment textile correction system based on artificial intelligence under computer parameter optimization design,” in In Journal of Physics: Conference Series, vol. 1881no. 4, p. 042017, IOP Publishing, 2021, April.
[11] T. Fong, I. Nourbakhsh, and K. Dautenhahn, "A survey of socially interactive robots," Robotics and Autonomous Systems, vol. 42, no. 3–4, pp. 143–166, 2003.
[12] M. H. B. de Moraes Lopes, D. D. Ferreira, A. C. B. H. Ferreira, G. R. da Silva, A. S. Caetano, and V. N. Braz, "Use of artificial intelligence in precision nutrition and fitness,” in In Artificial Intelligence in Precision Health, pp. 465–496, Academic Press, 2020.
[13] E. C. Makhni, S. Makhni, and P. N. Ramkumar, "Artificial intelligence for the orthopaedic surgeon: an overview of potential benefits, limitations, and clinical applications,” JAAOS-Journal of the American Academy of Orthopaedic Surgeons, pp. 5430–5435, 2020.
[14] E. J. Topol, "High-performance medicine: the convergence of human and artificial intelligence,” Nature Medicine, vol. 25, no. 1, pp. 44–56, 2019.
[15] K. K. Bhardwaj, S. Banyal, and D. K. Sharma, "Artificial intelligence based diagnostics, therapeutics and applications in biomedical engineering and bioinformatics,” in In Internet of Things in Biomedical Engineering, pp. 161–187, Academic Press, 2019.
[16] K. Dautenhahn, "Socially intelligent robots: dimensions of human–robot interaction,” Philosophical transactions of the royal society B: Biological sciences, vol. 362, no. 1480, pp. 679–704, 2007.
[17] A. P. Rodrigues, R. Fernandes, A. Shetty, K. Lakshmanna, and R. M. Shaifi, "Real-time Twitter spam detection and sentiment analysis using machine learning and deep learning techniques,” Computational Intelligence and Neuroscience, vol. 2022, 14 pages, 2022.
[18] A. Kurtz and R. Thomopoulos, "Safety vs. sustainability concerns of infant food users: French results and European perspectives,” Sustainability, vol. 13, no. 18, p. 10074, 2021.
[19] K. A. Paez, L. Zhao, and W. Hwang, "Rising out-of-pocket spending for chronic conditions: a ten-year trend,” Health Affairs, vol. 28, no. 1, pp. 15–25, 2009.
[20] J. Keim-Malpass, S. J. Ratcliffe, L. P. Moorman et al., "Predictive monitoring–impact in acute care cardiology trial (PM-IMPACCT): protocol for a randomized controlled trial,” JMIR Research Protocols, vol. 10, no. 7, article e29631, 2021.
G. Cai, Y. Fang, J. Wen, S. Mumtaz, Y. Song, and V. Frascolla, “Multi-carrier $ M $-ary DCSK system with code index modulation: an efficient solution for chaotic communications,” in IEEE Journal of Selected Topics in Signal Processing, vol. 13, no. 6, pp. 1375–1386, IEEE, May 2019.

C. Y. Chang, S. Bhattacharya, P. M. Raj Vincent, K. Lakshmanana, and K. Srinivasam, “An efficient classification of neonates cry using extreme gradient boosting-assisted grouped-support-vector network,” Journal of Healthcare Engineering, vol. 2021, 14 pages, 2021.

K. Chandra, A. S. Marcano, S. Mumtaz, R. V. Prasad, and H. L. Christiansen, “Unveiling capacity gains in ultradense networks: using mm-wave NOMA,” in IEEE Vehicular Technology Magazine, vol. 13, no. 2, pp. 75–83, IEEE, June 2018.

J. Du, C. Jiang, Z. Han, H. Zhang, S. Mumtaz, and Y. Ren, “Contract mechanism and performance analysis for data transaction in mobile social networks,” IEEE Transactions on Network Science and Engineering, vol. 6, no. 2, pp. 103–115, 2017.

S. Jabbar, F. Ullah, S. Khalid, M. Khan, and K. Han, “Semantic interoperability in heterogeneous IoT infrastructure for healthcare,” Wireless Communications and Mobile Computing, vol. 2017, 10 pages, 2017.

W. Raghupathi, “Designing clinical decision support systems in healthcare,” International Journal of Healthcare Information Systems and Informatics (IJHISI), vol. 2, no. 1, pp. 44–53, 2007.

Z. Zhang, C. Zhang, H. Li, and T. Xie, “Multipath transmission selection algorithm based on immune connectivity model,” Journal of Computer Applications, vol. 40, no. 12, p. 3571, 2020.

W. Xie, Z. Yao, E. Ji et al., “Artificial intelligence-based computed tomography processing framework for surgical telementoring of congenital heart disease,” ACM Journal on Emerging Technologies in Computing Systems (JETC), vol. 17, no. 4, pp. 1–24, 2021.

K. Lakshmanana and N. Khare, “FDSMO: frequent DNA sequence mining using FBSB and optimization,” International Journal of Intelligent Engineering & Systems, vol. 9, no. 4, pp. 157–166, 2016.

F. Ullah, M. A. Habil, M. Farhan, S. Khalid, M. Y. Durrani, and S. Jabbar, “Semantic interoperability for big-data in heterogeneous IoT infrastructure for healthcare,” Sustainable Cities and Society, vol. 34, pp. 90–96, 2017.

R. Ali, A. M. Khatak, F. Chow, and S. Lee, “A case-based meta-learning and reasoning framework for classifiers selection,” in In Proceedings of the 12th international conference on ubiquitous information management and communication, pp. 1–6, 2018, January.

R. Ali, S. Lee, and T. C. Chung, “Accurate multi-criteria decision making methodology for recommending machine learning algorithm,” Expert Systems with Applications, vol. 71, pp. 257–278, 2017.