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Clustering Students for Personalized Health Education Based on Learning Styles

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Abstract

Educating students on how to take responsibility for their health and make educated choices is a crucial step in fostering a culture of health and wellness. Health education may assist promote good health and prevent sickness at the personal, community, and societal levels by giving accurate and up-to-date knowledge on different health subjects, as well as the information and tools needed to adopt healthy habits. Health education is a strong force for promoting the overall health and well-being of students, individuals, and communities because of its numerous advantages, including the capacity to address health inequities and lower healthcare expenditures. The Felder-Silverman learning styles model may be used in health education to assist adjust teaching techniques to individual learners' needs and preferences. If a health educator is teaching a group of students about health, they may use a range of teaching strategies to meet the students' diverse learning styles. We used unsupervised machine learning techniques, K-means, and a hierarchical clustering algorithm to categorize 310 students into distinct categories based on sensory, intuitive, visual, and verbal following the Felder-Silverman Learning Styles Model. The experiments revealed three significant clusters. According to the results, students may be divided into at least three groups in order to produce individualized health education materials and methodologies for each group. We additionally discussed appropriate instruction approaches, contents, and pathways for each cluster of students. Hands-on activities, such as simulated patient situations, may be provided by the instructor for sensory learners. The instructor may communicate abstract ideas such as the function of various nutrients in the body to intuitive learners. For visual learners, the instructor may utilize diagrams or charts and for verbal learners, the instructor may provide lectures or printed materials. This research argues that the health educator may better guarantee that knowledge is properly transmitted to all students, irrespective of their learning style preferences, by using a range of teaching approaches.

Keywords: Health education, Hierarchical clustering, K-means, Personalized education, Students

Declarations

Competing interests:

The author declares no competing interests.

1. Introduction

The process of delivering knowledge to people, families, and communities about how to maintain and improve their health is referred to as "health education." It is intended to assist individuals in developing the abilities and knowledge necessary to maintain good health and prevent sickness, as well as in making educated decisions regarding their own health. Schools, businesses, community centers, and even medical facilities themselves are all potential locations for the delivery of health education programs to their respective populations. It may be taught through a variety of channels, such as face-to-face instruction, virtual learning environments, or printed materials, among others. The purpose of health education is to improve the overall health and well-being of a population. This is accomplished by raising awareness of issues pertaining to health, encouraging healthy behaviors, and providing the knowledge, abilities, and resources that are required to make educated decisions about one's own health [1], [2].

One of the most important advantages of receiving proper health education is that it enables individuals to make educated decisions concerning their own health. Health education helps people understand the risks and benefits associated with different behaviors, allowing them to make choices that are best for their overall health and well-being [3], [4]. This is accomplished by providing information that is accurate and up to date on a variety of health-related topics. Another advantage of receiving health education is the possibility that it will assist in the promotion of healthy behaviors. Health education can encourage individuals to adopt habits that can help improve their health and prevent illness by teaching people about the importance of things like regular exercise, a healthy diet, and stress management [5], [6]. These are all things that can be taught to people about the importance of health education.

Education about health issues can also have a beneficial effect on communities and people as a whole. Health education can contribute to an overall improvement in the health and well-being of a population by helping communities become more educated and gaining access to more resources [7], [8]. For instance, if a health education program is effective in

promoting healthy behaviors, it may have the potential to contribute to a reduction in the prevalence of chronic diseases in the population, such as obesity and diabetes. In addition, communities can have a better understanding of and ability to handle health-related challenges that are unique to their location with the assistance of health education. Some examples of these issues include concerns about environmental health and access to healthcare.

There are advantages for society to be gained from health education in addition to advantages on the level of the person and the community. Health education has the potential to contribute to a reduction in the cost of healthcare by encouraging individuals to engage in healthy activities and assisting them in making well-informed decisions regarding their own health. When people engage in healthy activities and take measures to prevent sickness, they lower their risk of being unwell and reduce their likelihood of requiring expensive medical treatment. This can assist to alleviate some of the strain placed on the healthcare system, so freeing up resources that can be put to use in other areas.

Education about health can also play a part in reducing health inequities and increasing access to medical care, both of which are important goals. Health education can assist in lowering the obstacles that prevent some individuals from gaining access to the necessary medical care by disseminating information and making resources available to members of underserved or marginalized populations [9], [10]. It is possible that this will help to enhance health outcomes and narrow the gap in health outcomes that now exists between various groups.

Lastly, education about health can assist in the development of a sense of personal responsibility about one's own health and well-being. Individuals can be empowered to take an active role in their own health and well-being through the use of health education. This is accomplished by providing people with the information and abilities that they need to take care of their own health. This can result in a better sense of control and autonomy, both of which can be beneficial to an individual's health and well-being on the whole.

2. Personalized health education

Personalized education, also known as personalized learning, is a teaching method that involves tailoring the learning experience to each student's unique requirements, abilities, and interests [11]. This can entail using a range of teaching methods and technologies, such as online resources and adaptive learning software, to create a learning environment that is

suited to each student's needs. Allowing students more flexibility over the speed and substance of their learning, as well as providing continuing support and resources to help them achieve, are all examples of personalized education. The purpose of personalized education is to increase student engagement and accomplishment by providing a more relevant, meaningful, and effective learning experience for each student [12], [13].

One of the primary advantages of individualized education is that it can increase student engagement and motivation. Personalized education can help keep students motivated and invested in their own learning by delivering a learning experience that is tailored to each student's specific requirements, abilities, and interests [14], [15]. This can result in higher levels of attendance and participation, as well as more enjoyment and satisfaction with the learning process. Personalized education can also help students achieve higher levels of success. Personalized education can help students better grasp and retain the subject they are studying by delivering a more relevant and effective learning experience. Higher exam scores and grades, as well as a deeper grasp and application of the subject matter, can result. Personalized education can have a favorable impact on the general classroom atmosphere in addition to the benefits for individual students. Personalized education can foster a more collaborative and inclusive learning environment by allowing students to work at their own speed and concentrating on their strengths and areas of need. This can lead to a sense of camaraderie and support among kids, as well as a reduction in disruptive behaviors. Teachers can also be more efficient and productive when using personalized education since they can adjust their teachings to the individual requirements of their students.

Personalized education can also assist in meeting kids' various learning demands. Teachers in typical classroom settings may struggle to meet the demands of every student because each student has distinct learning talents and needs. Teachers can utilize a number of approaches and technologies in personalized education to create a learning experience that is tailored to the individual needs of each student. This can help to ensure that every student, regardless of learning style or skill level, has the opportunity to learn and achieve. Personalized education can also help kids in the long run. Tailored education can help students develop the skills and information they need to thrive in their academic and professional pursuits by providing a more personalized and effective learning experience. This can result in improved outcomes in terms of college and career readiness, as well as general life success.

Finally, tailored education can help kids prepare for the future. Students must be able to adapt to changing conditions and learn new things throughout their lives in an increasingly digital and globalized society. Personalized education can help students develop the skills and habits they need to be successful learners and adapt to new difficulties throughout their lives by delivering a learning experience that is tailored to the particular needs of each student.

Personalized health education is a sort of health education that is personalized to the recipient's specific requirements and characteristics. Age, gender, cultural background, medical history, and personal preferences are examples of such information [16], [17]. Personalized health education is intended to assist people in making informed health decisions and taking an active role in maintaining their own health and well-being [18]. One-on-one counseling or coaching, group education programs, or the use of technology such as apps or online resources may be included. The purpose of personalized health education is to enable individuals to take responsibility of their own health and make long-term healthy decisions.

To effectively reach and engage individuals, a range of tactics can be employed in individualized health education. Among these strategies are:

One-on-one counseling or coaching: This method entails meeting with an individual in private to address their specific health issues and goals. A skilled health professional, such as a nurse, doctor, or counselor, can offer direction, support, and education to assist the individual in making educated health decisions.

Classes for group education: These programs are usually administered by a skilled health expert and bring together people who have similar health concerns or goals [19]. Group education sessions can be an effective strategy to give tailored health information in a more participatory and social environment.

Approaches based on technology: With the expansion of technology, there are now many tools accessible to assist individuals in accessing individualized health education. Apps that provide specialized health information and guidance, online classes and videos, and virtual coaching or counseling sessions are examples of this. These methods can be especially beneficial for persons who reside in distant places or have limited access to in-person health care.

While personalized health education has many potential benefits, it is critical to acknowledge and address the limitations and obstacles that can occur during implementation. Finding ways to make individualized health education more accessible, cost-effective, and time-efficient, as well as continuously monitoring and modifying the education to ensure it is effective in promoting better health outcomes, may be part of this [20]–[23].

Personalized health education has the potential to be a highly effective way to assisting individuals in making educated health decisions and taking an active role in maintaining their own well-being. However, various difficulties may develop during its execution.

One issue is the cost. Personalized health education frequently necessitates more resources and effort than more comprehensive health education programs. This can increase the cost of delivery, which can be prohibitive for some individuals and organizations. One-on-one counseling or coaching sessions, for example, might be time-consuming for the practitioner and may not be reimbursed by insurance. Additional resources, such as materials and facilities, may be required for group education programs. Apps or online courses that use technology may have one-time or recurring costs.

Another issue is limited access. Personalized health education may be scarce, especially in underserved or rural locations. This can make it difficult for people in these places to obtain the education and assistance they require to make informed health decisions. Access to tailored health education may be limited even in more metropolitan regions due to issues such as transportation difficulties or scheduling conflicts.

Time constraints might also make offering individualized health education difficult. Personalized health education frequently necessitates a large time investment on the part of both the provider and the individual receiving the instruction [24]–[26]. This can be difficult for busy people or health professionals with limited time to devote to one-on-one conversations. A busy parent, for example, may not have the time to attend a series of group education programs, and a health professional may not be able to provide individual counseling or coaching to all of their patients.

Finally, there is the issue of limited efficacy. Although individualized health education has the potential to be extremely helpful, it is not always effective in changing behaviors or improving health outcomes. This can be attributed to a number of factors, including the

intricacy of the health issue being addressed, the individual's willingness to change, and the quality of the teaching itself [22], [27], [28]. For example, a person may be motivated to make healthy changes but lack the skills or resources to put those changes into action in their daily lives. Alternatively, the education may not be individualized in such a way that it successfully meets the individual's unique requirements and concerns.

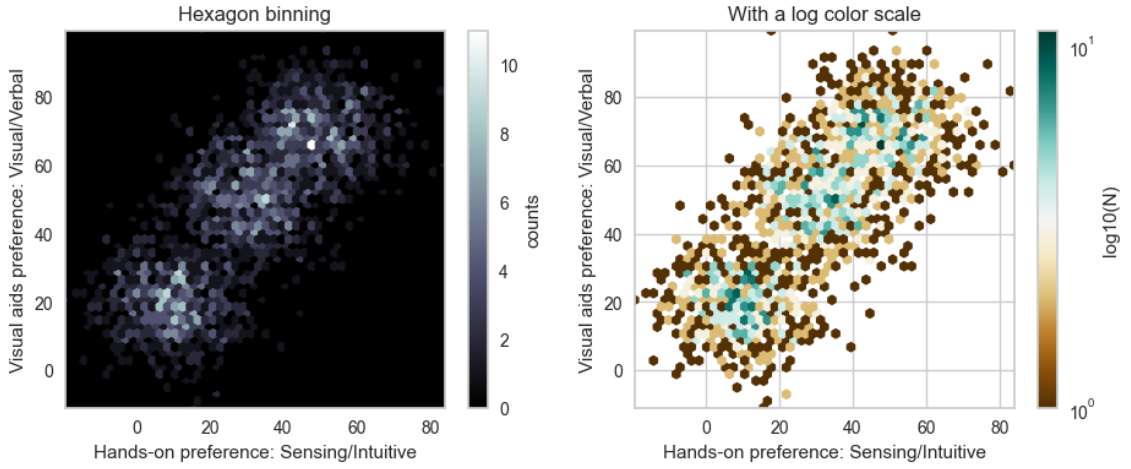
3. Model

The Felder-Silverman learning styles model is a learning theory that describes how different people have preferences for how they learn and absorb information. The approach categorizes learning modes as sensory, intuitive, visual, and verbal [29]–[33]. Sensory learners enjoy hands-on learning and are more inclined to interact with tangible objects or demonstrations. Intuitive learners prefer to learn through abstract concepts and are drawn to theories and ideas. Visual learners prefer visual tools such as diagrams, charts, and films to learn. Verbal learners prefer verbal explanations for learning and are more likely to interact with written or spoken language. Individuals may favor one or more of these learning styles, according to the model, and teaching approaches should be adapted to match the needs of diverse learners.

4. Results

Figures 1, 2, and 3 depict students clustering based on several dimensions of learning styles. Under K-means clustering techniques, there are three distinct students' groupings in all circumstances [34]–[39]. Figure 1 depicts students that are fewer active learners (more reflective) and less sensing learners (more intuitive). Students in the second grouping are more active learners (less reflective) but less sensing learners. Students in the third grouping are more perceptive but less engaged learners. Figures 2 and 3 show results that are nearly identical. As a result, students can be divided into three groups for more individualized health learning experiences. Figure 3 also demonstrates that there is no statistically significant link between x and y.

Figure 1. Student clustering K-means log scale

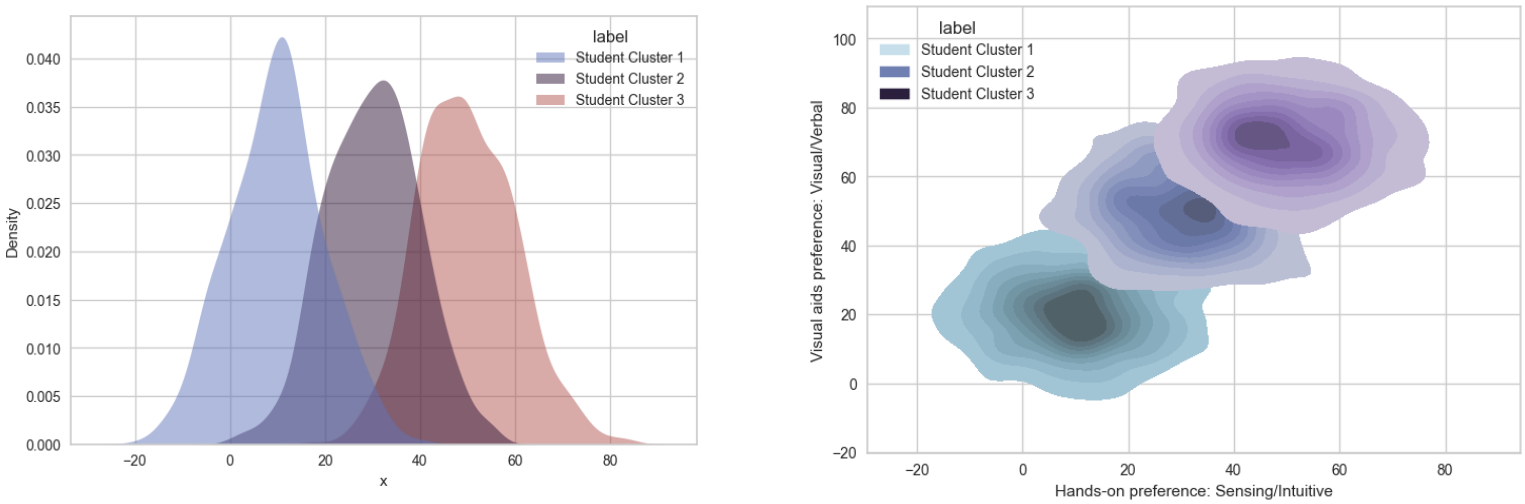


Sensory learners prefer to learn through hands-on experiences and interaction with actual things or demonstrations. There are numerous ways in health education that can be utilized to teach health to sensory learners.

Hands-on activities and experience learning are one effective way. This can involve exercises like food tastings or simulated patient scenarios where students can practice skills like vital sign taking or medicine administration. These activities allow sensory learners to interact with the material in a way that is meaningful to them, assisting them in understanding and remembering the information offered.

The utilization of multimedia materials such as films or interactive games is another useful way for teaching health to sensory learners. These materials enable students to see and experience the information in an engaging and interactive manner. A film depicting proper hand hygiene procedures, for example, can assist sensory learners in understanding the necessity of hand washing in reducing the spread of sickness. Interactive games and simulations can also be effective for teaching concepts like anatomy and physiology since they allow students to interact with the information in a more hands-on manner. Overall, while producing and presenting health education materials, health educators must consider the requirements and preferences of sensory learners. Educators may effectively teach health to this type of learner and help them grasp and retain the material being presented by employing hands-on activities, experiential learning, and multimedia resources.

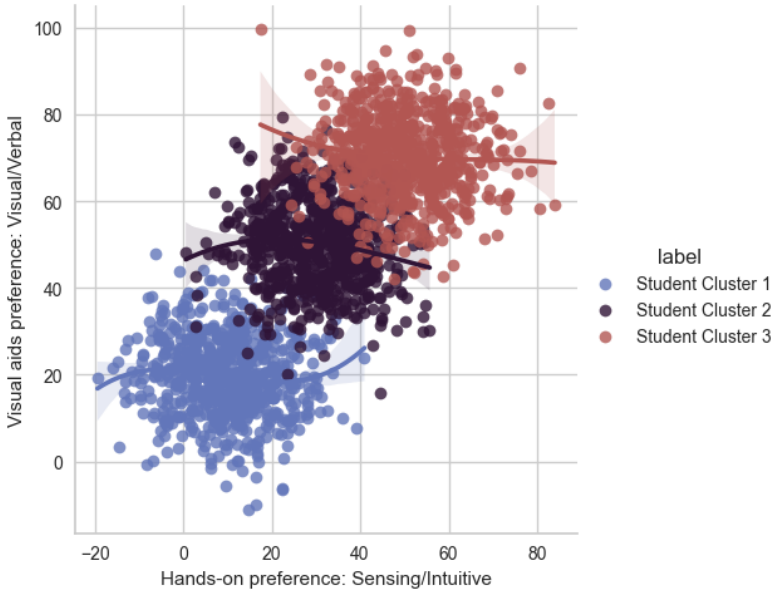
Figure 2. Distribution and variance of each student-clusters



Individuals who like to learn through abstract notions and are drawn to theories and ideas are considered intuitive learners. There are numerous ways in health education that can be utilized to teach health to intuitive learners. Discussion and argument are two useful methods. Intuitive learners frequently like considering alternative perspectives and the underlying concepts behind a concept. Allowing time in a health education lesson for discussion and debate can help intuitive learners engage with the subject in a meaningful way.

Case studies are another good way for teaching health to intuitive learners. Case studies enable students to apply their knowledge of abstract concepts to real-world scenarios, which may be both fascinating and challenging for intuitive learners. A case study on a patient with a difficult medical condition, for example, could be used to teach students about the fundamental concepts of illness management. Overall, when producing and delivering health education materials, health educators must address the requirements and preferences of intuitive learners. Educators may effectively teach health to this type of learner and help them grasp and recall the material being provided by employing strategies such as discussion and debate and case studies.

Figure 3. LM plot within each cluster



Individuals who like to learn using visual aids such as diagrams, charts, and movies are known as visual learners. There are numerous ways in health education that can be utilized to educate health to visual learners.

The use of visual aids such as diagrams, charts, and infographics is one efficient way. By giving a visual picture of the material being delivered, these aids can help pupils understand complex concepts. A graphic of the many sections of the cardiovascular system, for example, can assist pupils comprehend how the heart and blood vessels work.

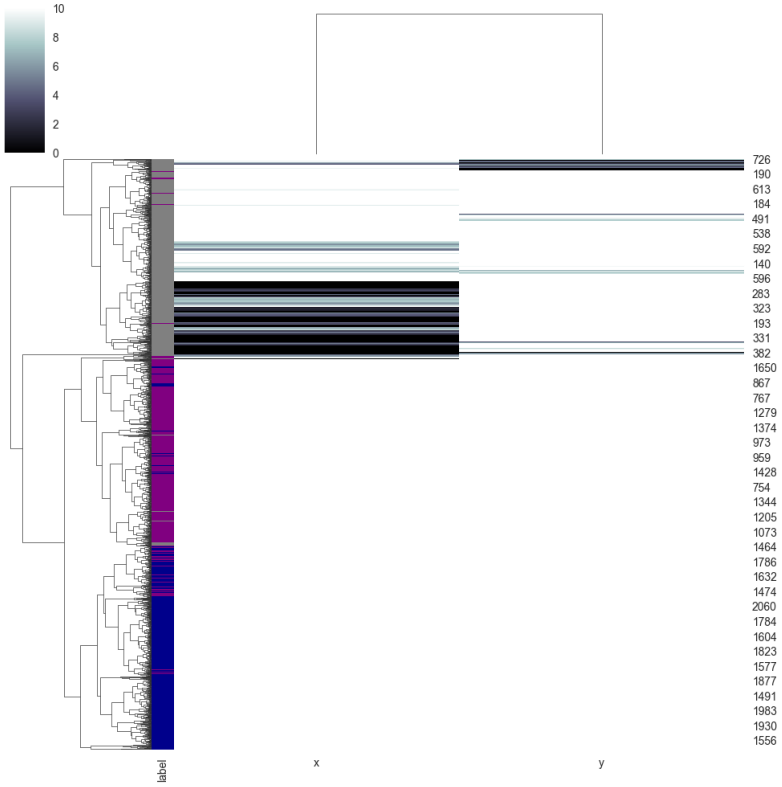
The utilization of multimedia tools such as movies or interactive simulations is another successful way for teaching health to visual learners. These materials enable students to see and experience the information in an engaging and interactive manner. A movie displaying proper drug administration technique, for example, can help visual learners grasp the processes involved in the procedure. Because they allow students to explore the topic in a more visual way, interactive simulations can also be effective for teaching concepts such as anatomy and physiology. Overall, while producing and delivering health education materials, health educators must address the requirements and preferences of visual learners. Educators

may effectively teach health to this type of learner and help them understand and recall the material being delivered by employing visual aids and multimedia tools.

Individuals who prefer to learn through verbal explanations and are more likely to interact with written or spoken language are classified as verbal learners [40], [41]. There are numerous strategies in health education that can be utilized to educate health to verbal learners.

The utilization of lectures or presentations is one efficient strategy. Verbal learners frequently benefit from hearing knowledge given in a clear, ordered manner, which lectures or presentations can provide. Slides or other visual aids can be used to enhance verbal explanations and provide a visual picture of the subject being presented.

Figure 4. Hierarchical clustering dendrogram



The use of written resources such as textbooks, articles, or handouts is another excellent way for teaching health to verbal learners. These materials enable students to read and interact with the material at their own pace, which can be beneficial for verbal learners who prefer to assimilate information slowly. Activities such as reading comprehension questions or writing tasks can help students engage with the topic more actively. Overall, when producing and delivering health education materials, health educators must address the requirements and preferences of verbal learners. Educators can effectively teach health to this sort of learner and help them understand and recall the material being provided by employing approaches such as lectures and written materials.

5. Conclusion

Health education is the process of providing people, families, and communities with information about health and wellness. It is intended to assist people in making informed health decisions and in developing the skills and information required to maintain good health and prevent sickness. Health education benefits include the potential to assist students make informed health decisions, promote healthy habits, and improve the overall health and well-being of communities and populations. Health education can help reduce healthcare expenditures, address health disparities, and instill a feeling of personal responsibility for one's health.

Personalized health education tactics that are tailored to the unique requirements and preferences of the student receiving the instruction will be the most effective. In order to design a personalized and successful plan for improving their health and well-being, health educators can consider various learning styles of students.

The Felder-Silverman learning styles model is a learning theory that describes how different people have preferences for how they learn and absorb information. The approach categorizes learning modes as sensory, intuitive, visual, and verbal. Sensory learners enjoy hands-on learning and are more inclined to interact with tangible objects or demonstrations. Intuitive learners prefer to learn through abstract concepts and are drawn to theories and ideas. Visual learners prefer visual tools such as diagrams, charts, and films to learn. Verbal learners prefer verbal explanations for learning and are more likely to interact with written or spoken language. To accommodate their students' different learning styles, health educators can use a variety of teaching methods, such as hands-on activities and experiential

learning for sensory learners, discussion and debate and case studies for intuitive learners, visual aids and multimedia resources for visual learners, and lectures and written materials for verbal learners.

Personalized health education has the potential to be an extremely effective strategy for improving both individual and population health. However, various difficulties may develop during its execution. Cost, restricted availability, time limits, and limited effectiveness are among the issues. Recognizing and addressing these obstacles is critical to ensuring that tailored health education is accessible, cost-efficient, and effective in promoting beneficial health outcomes for students.

References

[1] K. Glanz, B. K. Rimer, and K. Viswanath, "Health behavior and health education: theory, research, and practice," 2008.

[2] A. Bandura, "Health promotion by social cognitive means," *Health Educ. Behav.*, 2004.

[3] D. Dunning, C. Heath, and J. M. Suls, "Flawed self-assessment: Implications for health, education, and the workplace," *Psychol. Sci. Public Interest*, 2004.

[4] K. R. McLeroy, D. Bibeau, and A. Steckler, "An ecological perspective on health promotion programs," *Health Educ.*, 1988.

[5] L. W. Green and M. W. Kreuter, "Health education planning," 1991.

[6] H. Jung, K. von Sternberg, and K. Davis, "Expanding a measure of mental health literacy: Development and validation of a multicomponent mental health literacy measure," *Psychiatry Res.*, vol. 243, pp. 278–286, Sep. 2016.

[7] D. Nutbeam, "Health literacy as a public health goal: a challenge for contemporary health education and communication strategies into the 21st century," *Health Promot. Int.*, vol. 15, no. 3, pp. 259–267, Sep. 2000.

[8] Institute of Medicine (US) Committee on Health Literacy, *Health Literacy: A Prescription to End Confusion*. Washington (DC): National Academies Press (US), 2004.

[9] U. States. Public Health Service, "Healthy people 2000: National health promotion and disease prevention objectives," 1991.

[10] H. Promotion, "Guide to clinical preventive services: report of the US Preventive Services Task Force," 1996.

[11] N. Dabbagh and A. Kitsantas, "Personal Learning Environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning," *The Internet and higher education*, 2012.

[12] V. V. Sadovaya, O. V. Korshunova, and Z. Z. Nauruzbay, "Personalized education strategies," *Int. Electron. J. Math. Educ.*, vol. 11, no. 1, pp. 199–209, Apr. 2016.

[13] K. Chrysafiadi and M. Virvou, "Student Modeling for Personalized Education: A Review of the Literature," in *Advances in Personalized Web-Based Education*, K. Chrysafiadi and M. Virvou, Eds. Cham: Springer International Publishing, 2015, pp. 1–24.

[14] M. Sharples, "The design of personal mobile technologies for lifelong learning," *Comput. Educ.*, 2000.

[15] J. G. Ruiz, M. J. Mintzer, and R. M. Leipzig, “The impact of e-learning in medical education,” *Acad. Med.*, 2006.
[16] C. Tekin, J. Braun, and M. van der Schaar, “eTutor: Online learning for personalized education,” in *2015 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, 2015, pp. 5545–5549.
[17] R. Reber, E. A. Canning, and J. M. Harackiewicz, “Personalized Education to Increase Interest,” *Curr. Dir. Psychol. Sci.*, vol. 27, no. 6, pp. 449–454, Dec. 2018.
[18] D. A. Kolb and R. E. Boyatzis, “Experiential learning theory: Previous research and new directions,” *on thinking, learning, and …*, 2014.
[19] J. H. Waldeck, “What Does ‘Personalized Education’ Mean for Faculty, and How Should It Serve Our Students?,” *Commun. Educ.*, vol. 55, no. 3, pp. 345–352, Jul. 2006.
[20] J. H. Waldeck, “Answering the Question: Student Perceptions of Personalized Education and the Construct’s Relationship to Learning Outcomes,” *Commun. Educ.*, vol. 56, no. 4, pp. 409–432, Oct. 2007.
[21] W. Villegas-Ch and S. Luján-Mora, “Analysis of data mining techniques applied to LMS for personalized education,” in *2017 IEEE World Engineering Education Conference (EDUNINE)*, 2017, pp. 85–89.
[22] W. Weinlich, “Was kann die Was kann die Kunstpädagogik für die Inklusion leisten? Ein Impuls für die Primarstufe und darüber hinaus,” *R&E-SOURCE*, 2018.
[23] W. Weinlich, “Musikalische Symbole,” *Journal of Elementary Education*, 2017.
[24] D. R. Garrison, “Self-directed learning: Toward a comprehensive model,” *Adult education quarterly*, 1997.
[25] N. Tzenios, “The Determinants of Access to Healthcare: A Review of Individual, Structural, and Systemic Factors,” *Journal of Humanities and Applied Science Research*, vol. 2, no. 1, pp. 1–14, 2019.
[26] N. Tzenios, “The Impact of Health Literacy on Employee Productivity: An Empirical Investigation,” *Empirical Quests for Management Essences*, vol. 3, no. 1, pp. 21–33, Nov. 2019.
[27] S. Rendle, C. Freudenthaler, and Z. Gantner, “BPR: Bayesian personalized ranking from implicit feedback,” *arXiv preprint arXiv*, 2012.
[28] W. Weinlich, “The Contribution of Art Education to Educational Transitions,” *Journal of Elementary Education*, 2018.
[29] M. M. El-Bishouty *et al.*, “Use of Felder and Silverman learning style model for online course design,” *Educ. Technol. Res. Dev.*, vol. 67, no. 1, pp. 161–177, Feb. 2019.
[30] S. Muruganandam and N. Srinivasan, “Appraisal of Felder - Silverman learning style model with discrete data sets,” *Indian J. Sci. Technol.*, vol. 9, no. 10, Mar. 2016.
[31] J. Salah, “A note on the modified Caputo’s fractional calculus derivative operator,” *Far East J. Math. Sci.* , vol. 100, no. 4, pp. 609–615, Sep. 2016.
[32] J. Y. Salah, “CLOSED-TO-CONVEX CRITERION ASSOCIATED TO THE MODIFIED CAPUTO’S FRACTIONAL CALCULUS DERIVATIVE OPERATOR,” *Far East J. Math. Sci.* , 2017.
[33] J. Salah and S. Venkatesh, “Inequalities on the Theory of Univalent Functions,” *Journal of Mathematics and System*, 2014.
[34] J. Salah and M. Darus, “A subclass of uniformly convex functions associated with a fractional calculus operator involving Caputo’s fractional differentiation,” *Acta Universitatis Apulensis. Mathematics-Informatics*, 2010.
[35] H. U. Rehman, M. Darus, and J. Salah, “A note on Caputo’s derivative operator interpretation in economy,” *J. Appl. Math.*, 2018.

[36] H. Rehman, M. Darus, and J. Salah, “Coefficient properties involving the generalized k-Mittag–Leffler functions,” *tjmm.edyropress.ro*, 2017.
[37] J. Salah and M. Darus, “A note on generalized Mittag-Leffler function and application,” *researchgate.net*, 2011.
[38] C. Ming and V. Viassolo, “Machine learning techniques for personalized breast cancer risk prediction: comparison with the BCRAT and BOADICEA models,” *Breast Cancer*, 2019.
[39] R. Collobert and J. Weston, “A unified architecture for natural language processing: deep neural networks with multitask learning,” in *Proceedings of the 25th international conference on Machine learning*, Helsinki, Finland, 2008, pp. 160–167.
[40] J. F. Pane, E. D. Steiner, M. D. Baird, and L. S. Hamilton, “Continued Progress: Promising Evidence on Personalized Learning,” *Rand Corporation*, 2015.
[41] P. H. Wien, “Empowering Future (artistic) Acting: Values and Service-Learning.”