

# Artificial Intelligence usage in India Analysed Using Six Hat Management Thinking Tools

D. Ananthpadmanaban

*Associate Professor, Department of Mechanical Engineering, Sri Sivasubramaniya Nadar College of Engineering, Kalavakkam-603110*

**Abstract**–Artificial intelligence has been used in Industries for several years and its usage is only increasing in recent times. The six-hat method of analyzing problems also is a time-tested management technique. This paper attempts to weld these two techniques and analyze the impact of six-hat thinking on artificial intelligence, which is a novel way of thinking. The pros and cons have been analyzed for three different situations in the Indian context, two Industrial, namely casting and welding and one Educational. This intermingling of these two modern concepts is a novelty, which may not have been attempted before. Conclusions have been made based on the analysis.

**Keywords**–Artificial Intelligence, Six-hat thinking, Case studies,

## I. INTRODUCTION

The term artificial intelligence was termed in the year 1956. But it is only in recent times that AI is being seriously considered and used in a widespread manner. The reason is not hard to fathom. Tremendous increases in the human population have given rise to a large data volume across all fields. This data management is not quite possible without artificial intelligence. Even though the use of Artificial intelligence has been propounded a few decades back and a lot of theoretical work has been done in this area, it was not until 5 or 6 years back that AI gained more ground.

COVID-19 came as a challenge for all of us and people were forced to work from home. In a way, this came as a blessing in disguise because professionals all over the world were forced to perform more research in AI and help people in dire need of it. When we were out of COVID, still many professionals continued to work from home and AI became a more powerful tool to aid this. This work-from-home culture indirectly benefits mankind because the number of automobiles used became less and emissions reduced. This led to a cleaner and greener earth.

Six-hat thinking is a management tool, which is very simple in nature. There are six colours given to the six hats and each colour represents a mode of thinking. The next section will deal more in detail with six-hat thinking. This mode of problem-solving has benefitted many multinational corporations like Boeing, which were struggling to find solutions to complex problems.

Some of the data may be mutually contradictory and we need algorithms to sift the data and sort out meaningful data. By 2020, it is estimated that 44 trillion GB of data will be available on hand to analyze. Tesla company's self-driving car and Robot playing chess are some examples of artificial intelligence.

The discussion which follows is an amalgamation of the concept of artificial intelligence, with six-hat thinking and it is a novel way of problem solving.

## II. LITERATURE SURVEY

Six-hat thinking was introduced by Eduard De Bono. Many Management meetings tend to start at a point and go beyond the actual agenda. In order to stick to the agenda, De Bono introduced six hats of different colours. They are explained in detail in a later section of this paper. Each of these hats organizes our thinking in a certain direction, not allowing us to lose focus on the actual problem. [1]. Each of the hats also has a specific purpose and all hats put together determine the final decision on the problem at hand.

It should be mentioned here that no hat is either superior or inferior to any other hat. Each hat just shows a mode of thinking and all modes of thinking are used in detail when we make use of six thinking hats.

A lot of conflicting data exists in today's era. Hence, artificial intelligence packages help in removing unnecessary data and making use of relevant ones [2]. Artificial intelligence involves a lot of critical thinking and critical inputs.

Critical thinking, according to Miller has to do with induction and deduction, without having any bias [3]. The phrase without any bias assumes significance here. De Bono has practically demonstrated this concept while using this in several practical situations. One of the first papers on the use of six thinking hats was by Walter John at the University of North Carolina. The application was a thinking model [4].

Six-hat thinking has been used effectively in managing meetings in as diverse applications as Hospital meeting management [5], Human Resource Analytics [6] and medical simulations [7].

Table -1 Different Types of Hats

COLOURED HAT	IDEA OF THE HAT	DESCRIPTION
White	Blank white sheet	Presently available data,bare facts and figures
Red	Fire	Feelings and emotions without being prejudiced
Yellow	Sunshine,Brightness	Positive side of things
Black	Judge without bias	Caution and critical judgement
Green	Rich vegetation	Creative thinking
Blue	Sky	Summarises and Concludes

Table 1 given above shows the different types of hats.

### III. THE SIX HATS APPLIED TO AI

White hat thinking-As given in Table 1,white hat just gives the facts in black and white.It is the first hat in six hat thinking and the basis for all the other thinking.This hat just gives data in the raw form and it is for the experts and other educationalists to analyse the data in the proper manner.Proper analysis of all data can be done accurately only if a balanced analysis of all hats is done. Deep blue,a computer has beaten some of the chess world champions.This is a fact and hence,computers can be programmed to do just about anything.That is the reality today. Especially after COVID,AI and its applications have increased many fold and new courses in AI and machine language were started throughout the world.

Red Hat- Red indicates feelings and emotions. Red is a colour showing warning and perhaps warns of our feelings,also called gut feelings.Many times,it turns out that gut feelings are correct.Many times,we have a hunch that things will work out or won't work out.The argument against using AI in the industry could be that there could be enormous job losses. But,in fact,some jobs may be lost and some other new jobs could be generated. So,there is an unfounded fear that manual jobs could be lost.

Intellectual thinking is also allowed.For example, it is still unclear what are the benefits of artificial intelligence,which is really true.Only time will tell.There is a general feeling that man's life will become more mechanical and critical thinking will be lost.All thinking will be done by computers and man could blindly believe computers.Computers are only as good as the programs that went into making of the computers. So,an intelligent man is always ahead.

Yellow hat-Yellow indicates the sunny side of thingsbut is again lopsided.It shows only the positive side of the problem.For a thorough analysis of the problem,all sides of the problem should be looked into.Computers have developed by leaps and bounds over the last decade. Robots are also being used extensively in countries like Japan and Singapore.For example-Some robots help old people do mundane things like heating their food.

Black hat-Black hat thinking advises caution in action.It takes into account all the pros and cons before making a final decision.It cautions one against jumping too fast into anew arena.This hat of caution and experience has shown that this is one of the most used hats.Every problem should be approached with utmost caution and sudden decisions should be avoided.

When any new invention is being tried out, most people unconsciously use the black hat thinking.One serious way of black hat thinking is- If software goes haywire due to some technical glitch, will it be self-destructive as shown in some movies on science fiction. This fear is indeed real because many incidents which were in the realm of science fiction 20 or 30 years back have become reality today.

Green hat thinking-The colour green gives us a pleasant feeling since this is the natural colour of trees. It is the colour of creativity and growth and hence represents something growing.This hat shows the growth and creativity aspects and is a positive hat.

Due to the advent of Covid and the drastic changes in many societies,many small-scale industries and large-scale industries have turned to AI applications not only to improve their productivitybut just to stay afloat in the new digital scenario.It is in this context that this paper was prepared to judiciously evaluate the advent of AI in three specific cases.The technique used is six-hat thinking,which has proved an effective tool across all sectors and which has reduced voluminous paperwork and discussionswhile analysing practical problems in Industries.

SME owners from various sectors who undertook a seven-week programme to build foundational knowledge on the opportunities of AI for their businesses and sectors.The programme was successful and AI applications were recognized,especially after the pandemic.

Case studies in the casting industry, the welding industry and general education have been chosen for their obvious utility in manufacturing and for society at large. The discussions in this paper are general in nature and more work can be done systematically to improve the findings.

#### IV. CASE STUDIES

##### A. Case Study I(a)- AI in Foundry technology

Taguchi methods have been used to predict defects in casting. The effects of the selected parameters on the porosity formation and the subsequent optimal setting of the parameters have been accomplished using the Taguchi approach [8].

Work has been done on the application of AI in a foundry in Belgavi [9]. Another work has shown that, I, metal casting is an unbalanced, semi-supervised learning problem which is challenging for even state-of-the-art machine learning algorithms [10]. One of the main tasks in developing the machine learning model is to work meaningfully with unbalanced raw datasets supplied by foundries. Though knowledge extracted directly from these front-line datasets can provide meaningful guidance on process and quality control to foundries, the process of converting these data into knowledge is quite challenging for data scientists. The lifeblood of successful foundries is the large-scale production of defect-free products. Accordingly, only a small percentage of defective products are available to train the machine learning algorithm.

Foundry is one of the oldest manufacturing units and innovations have been going on continuously to improve production. Various software and 3D modelling have been in vogue for the last 25 years in foundries and expert systems are also available in order to predict the nature and rectification of faults. Experimental data have been collected for one month and the results were analyzed using a rule-based expert system [11]. Generally, the problems faced in foundries and welding Industries are similar and so we group them together. A lot of work has been done in the area of expert systems in Foundries. AI is only an extension of expert systems. Similarly, expert systems have also been used for defect detection and prediction in welding industries. Welding is a form of mini solidification and solidification is casting. Hence, welding is a mini foundry technology. Therefore, it will not be very difficult to extend the same principles both to the foundry and welding Industry.

In foundries, one of the main problems is defect identification and rectification. Sudeesh Kannan et al brought out an expert system which deal with defect identification and rectification way back in the 1990s in possibly the first work on expert systems in foundrie [12].

White hat thinking- As given in Figure 1, white hat just gives the facts in black and white. It is the first hat in six hat thinking and the basis for all the other thinking. Get all the facts right. This hat just gives data in the raw form and it is for the experts and other educationalists to analyse the data in the proper manner. Proper analysis of all data can be done accurately only if a balanced analysis of all hats is done. Get the data on the presence of defects for at least a month from a recognized foundry. Search for the right AI tool – For Example – C and C++ tools are used widely for AI in foundries. Our group has also done a small study on the use of AI in foundries making use of data from Hinduja foundries [13].

Red hat thinking- It indicates feeling and emotions. Red is a colour showing warning and perhaps warns of our feelings, also called gut feelings. Many times, it turns out that gut feelings are correct. There are a lot of actual experts in foundries. They have worked on foundry-related problems for years. There is a chance that they will lose their jobs. Another line of thinking is- Just by giving data on quantifiable parameters like porosity and green strength, there is a doubt that actual defects can be accurately identified every time. Sometimes, for the same set of data, there may be two or more defects that match the data and we cannot pinpoint them. For this purpose, human beings are also required. We cannot entirely do away with human beings. The general feeling is that still it is too early for AI to be used extensively and both pros and cons should be discussed.

Yellow hat- Yellow indicates the sunny side of things but is again lopsided. It shows only the positive side of the problem. For a thorough analysis of the problem, all sides of the problem should be looked into. It is a fact that in the present world, AI and ML are already into technology in a big way and ChatGPT is a very good example. It is enough to say that AI and ML are just extensions of expert systems, but a step forward in a positive direction. The world always moves forward and there is no looking back. In that sense, the positivity and the connect are real.

Black hat thinking- Black hat thinking advises caution in action. It takes into account all the pros and cons before making a final decision. It cautions one against jumping too fast into a new arena. Old is gold and we have survived all these years without. Also, why make a fuss about AI? Will it work in the Indian context? India is such a large economy with a huge population. One must consider the practical difficulties in implementing AI. One should hold regular meetings with Industry leaders before taking the jump. Any wrong way of implementation of such a good technology could be disastrous for the whole country. Every problem should be approached with utmost caution and sudden decisions should be avoided.

Green hat thinking- The colour green gives us a pleasant feeling since this is the natural colour of trees. It is the colour of creativity and growth and hence represents something growing. Productivity is enhanced by using AI tools. In fact, thinking itself is reduced as all you do is- feed the data into an AI-based expert system and get the output as the probable defect that is present. This sort of effort will do away with many of the laborious jobs that are done by human beings. Instead, human beings can just control and monitor the AI-based system.

It will in fact bring down stress because most of the human-related stress is caused by thinking out solutions from a large pool of data.

Blue hat thinking- In summary, it can be argued that AI in foundries has been existing in a different form for the last 25 years, but its importance is felt more in recent times as optimization tools and critical thinking help optimum productivity with minimum wastage of resources.

One expert system developed by our group was able to predict defects and also give suggestions on defect prevention. The two Figures shown below are practical studies done by our group.

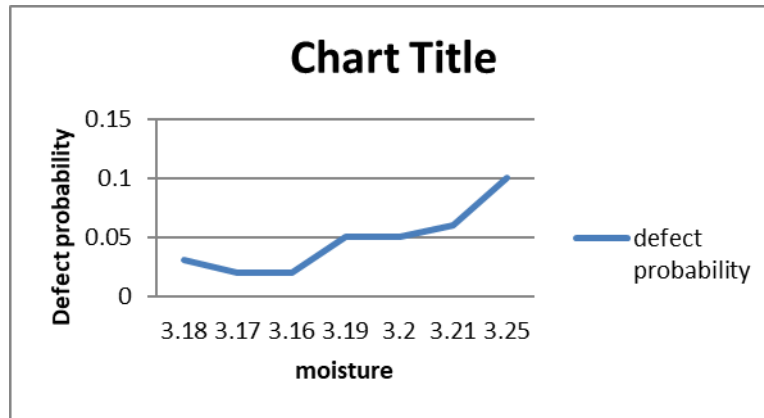


Figure 1-Probability of blowholes vs moisture content

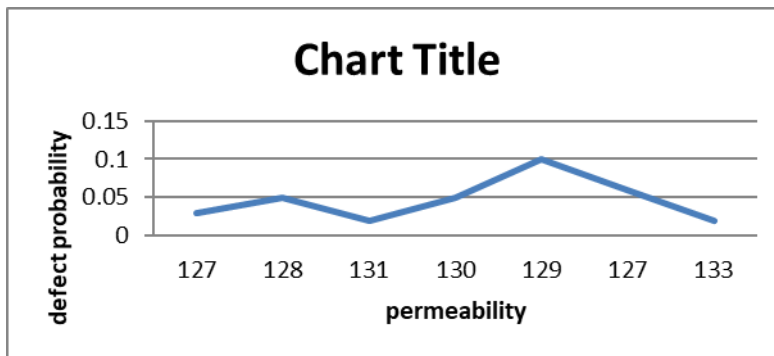


Figure 2- Probability of defect vs permeability of green sand

#### B. Case study 1(b)- AI used in welding

White hat thinking—This hat just gives data in the raw form and it is for the experts and other educationalists to analyse the data in the proper manner. Proper analysis of all data can be done accurately only if a balanced analysis of all hats is done. AI applications in welding would be in the analysis of weld zone and microstructures. Already, microstructures are being analyzed using image analysis software, which collects data from the microstructure and analyzes them for defects and proper use of weld parameters. Product applications are also analyzed using this software [14,15,16].

Red hat thinking-It indicates feeling and emotions. Red is a colour showing warning and perhaps warns of our feelings, also called gut feelings. Many times, it turns out that gut feelings are correct. The gut feeling in this case of AI applied to welding is that many conventional jobs would be lost. This is only common sense and does not require any great degree of analysis. These jobs that are lost should be compensated by new jobs. The general feeling is that still it is too early for AI to be used extensively and both pros and cons should be discussed.

Black hat thinking-Black hat thinking advises caution in action. It takes into account all the pros and cons before making a final decision. It cautions one against jumping too fast into a new arena. A lot of computerization has been happening over the last two decades, which is good and reliable data can be stored and accessed more easily. The black hat cautions that pushing into a new area of modern technology too fast could be detrimental even to good technologies. Hence it advises caution, a slow approach and approaching AI slowly and gradually so that the ill effects of new technology will not be felt by the lower sections of society. Every problem should be approached with utmost caution and sudden decisions should be avoided.

Yellow hat thinking-Yellow indicates the sunny side of thingsbut is again lopsided. It shows only the positive side of the problem.For a thorough analysis of the problem,all sides of the problem should be looked into Inverters are used for AC to DC conversions in welding.With the help of sensors, we can sense exactly the DC current required for a particular type of welding.Artificial Intelligence can be used in sensors.

The first potential use of AI in welding was done by Jonas and Rock in the year 1990.They could sense the use of AI in welding even at that time[17]. Their sense of the future has come true now, but it has come to practical use faster than expected.

Green hat thinking-The colour green gives us a pleasant feeling since this is the natural colour of trees. It is the colour of creativity and growth and hence represents something growing.

Blue hat thinking- We can summarize by saying that There is a lot of opportunity for AI in the metallurgical and mechanical Industries.Already,some big players are using AI and one should not miss out on this opportunity

### C. Case Study II -AI in Schools/Colleges

There are some reviews and talks which suggest that AI could be introduced in schools and colleges.During the early 1980s,computers were introduced in schools and it was a revolutionary thing at that time.Now,all school students know C,C++ and Java.Similar is the case with AI in schools.

A six-hat thinking line of thought is as follows-

White hat-As given in Figure 1,white hat just gives the facts in black and white.It is the first hat in six hat thinking and the basis for all the other thinking.All facts should be given,taking into account the latest facts and figures.This hat just gives data in the raw form and it is for the experts and other educationalists to analyse the data in the proper manner. Proper analysis of all data can be done accurately only if a balanced analysis of all hats is done.

Facts and figures show that the future is in AI and machine language. India produces around 750 research papers per year compared to 3500 in China. This vast amount of research data comprises a wealth of information and can be used for analysis on how to improve society as a whole. The number of research papers in AI and ML are increasing rapidly year by year and their applications will increase exponentially in future also.

Red hat thinking

It indicates feeling and emotions. Red is a colour showing warning and perhaps warns of our feelings,also called gut feelings. Many times,it turns out that gut feelings are correct. While machine learning and artificial intelligence are picking up the world over,how do you use these technologies in the context of India?These technologies are still in their infancy and it takes a long time for a technology to develop.India, being a developing country with a very diverse population and very different languages and cultures,it becomes more difficult for a technology to be accepted and the new technology practised.To what extent will the schools accept the syllabus in these areas?Should we have a separate hour for these subjects,say once or twice a week? Unless this is supported by laboratory work or computer simulation models,this will not work.The general feeling is that still it is too early for AI to be used extensively and both pros and cons should be discussed.

Black hat thinking

Black hat thinking advises caution in action.It takes into account all the pros and cons before making a final decision.It cautions one against jumping too fast into anew arena.The education system in India is not entirely centralized and there may be many divergent views on including AI in the curriculum. So, once again, Committees have to be set up with experts like for example-Prof.Dinesh Kumar of IIM(B) in order to study this issue.In the beginning,it would be a good idea to introduce this into the curriculum of select schools,get feedback and then modify the proposal based on the feedback. In this context, it should be mentioned that NPTEL courses are available and run by IIT faculty, These are online courses with moderate success rates and many college students are enrolling in these courses,at present. These courses should be marketed in a better manner and publicized so that more and more college students are attracted to them.

Yellow hat thinking

Yellow indicates the sunny side of thingsbut is again lopsided.It shows only the positive side of the problem.For a thorough analysis of the problem,all sides of the problem should be looked into (Massachusetts Institute of Technology) is investing 1 billion dollars in a college for AI. So,why don't we also invest in India?AI is going to be the future of the world,so we all should take all possible steps to promote AI, especially in colleges.Some boring, repetitive jobs could be replaced by machine learnt jobs and human beings can then concentrate on really creative jobs.So,it will definitely pay to introduce AI in the curriculum,in the long run.Research has been done on the effect of AI on teaching and learning [18]. Some of the functions of AI in the field of Education have also been summarized in a recent article by UchchukwuAjuzieogu[19]. Already AI and ML have been widely used in developed countries and it will not be long before it becomes common in India.B.Tech-AI and ML are being offered by some good private Universities and I.I.Ts.So, it seems that in future,there will be light at the end of the tunnel and already some light can be seen.Another recent article highlighting students AI collaborations has been researched.Perspectives of teachers are given in this article[20]. In recent times, the education field has integrated non-human agents as collaborative agents.These agents act as tutors, teaching assistants,advisors and learning peers[21]. ChatGPT in recent times is a good example of a practical AI application as a tutor,teaching assistant and helper.There is an argument that student's creativity can

never be entirely replaced and at best AI can be only a supplement to already existing tools. So, it should be used in a very judicious manner. Otherwise, there is a danger that human beings will be nothing more than intelligent robot [22,23]. UNESCO has advocated a bottom-up approach in which all the stakeholders are involved. Academia, public-private partnerships and collaborations are necessary to put these ideas into practice [24]. Grammarly, which is being widely used in research corrections and other English corrections gives better ways to frame sentences, rather than simply rephrasing sentences.

#### Green hat thinking

The colour green gives us a pleasant feeling since this is the natural colour of trees. It is the colour of creativity and growth and hence represents something growing. Some Indian companies like Flipkart and BigBasket have already used AI for practical applications. A lot of data are available these days with many researchers working on practical problems. AI can help to automate college admissions. Already, I.I.T, Hyderabad and Great Lakes International University have programs at the college level in India. So, it will definitely help if the basics are taught in the school itself. A useful review of the use of AI in the field of education has been done by Mehmed Fahimirad [25]. The practical usage of AI tools in education in Brazil has been outlined by Carla De Silva et al. [26]. The same analysis in an Indian context has been discussed in detail by V.V. Subramanyam et al [27].

Blue hat thinking is a hat which summarizes the research work, and other ideas studies. It may be too early to introduce AI in the school curriculum. So, more studies should be done with the help of experts. to see if this is practical.

### V. CONCLUSIONS

Three case studies have been presented on the practical applications of Artificial Intelligence. The Foundry area, welding area and educational area have been discussed in detail. Six-hat thinking has been applied to analyse the pros and cons of using AI in the Metallurgical Industry and Learning AI in schools. In every case study, the same sequential order of thinking was made use of namely-White hat, Red, Yellow, black, green and blue hat thinking and all the hats were discussed according to the practical problem at hand. One real-time data from our research work has also been presented.

There is no doubt that AI is already playing an important role throughout the world and the analysis shows that India should also invest heavily in AI in order to catch up with developed countries and stay globally relevant. But, care should be taken while implementing proposals. All stakeholders should be invited to share their views so that a collective decision can be taken.

It may take some time for the current and latest technologies to be accepted the world over and there is also the threat of losses of existing jobs. Hence, it is felt that these new technologies should be gradually introduced and utmost care should be taken so that jobs are not lost.

### REFERENCES

- [1] De Bono, E. (1985). *Six Thinking Hats*. London: Penguin Books.
- [2] Kivunja, C. (2014). Do You Want Your Students to Be Job-Ready with 21st Century Skills? Change Pedagogies: A Pedagogical Paradigm Shift from Vygotskian Social Constructivism to Critical Thinking, Problem Solving and Siemens' Digital Connectivism. *International Journal of Higher Education*, 3, pp 81-91. <http://dx.doi.org/10.5430/ijhe.v3n3p8>
- [3] Miller, S. (1990). Critical Thinking in Classroom Discussion of Texts: An Ethnographic Perspective. The Annual Meeting of the American Educational Research Association, ERIC Document Reproduction Service No. ED320886, Boston, 9 April 1990, pp 67-81.
- [4] *Six Thinking Hats: Argumentativeness and Response to Thinking Model*, Walter John Carl III, (1996) International Conference of Southern States Communication Association, March 1996, Memphis, TN
- [5] Six thinking hats as a creative approach in managing meetings in hospitals Eman Salman Taie1, Ahmad A. El kamel, (2013) *Journal of Nursing Education and Practice*, Vol. 3, No. 9
- [6] *Smruti Patre, Six Thinking Hats Approach to HR Analytics*, South Asian Journal of Human Resources Management, (2016) Volume 3, Issue 2, December 2016, pp 191-199
- [7] Zhang X, Lee H, Rodriguez C, et al. (April 27, 2018) *A Novel Approach to Debriefing Medical Simulations: The Six Thinking Hats*. *Cureus* 10(4): e2543. DOI 10.7759/cureus.2543
- [8] Design and analysis of sand casting process of mill roller Tegegn Hailemariam Hirigo1 & Balkeshwar Singh, (2019) *The International Journal of Advanced Manufacturing Technology* 105: pp2183–2214
- [9] *Praveen M. Kulkarni, Prayag Gokhale, L. V. Appasaba, K. Lakshminarayana & Basavaraj S. Tigadi*, (2023) *Artificial Intelligence and Machine Learning for Foundry Industry—A Case Study of Belagavi Foundry Industry*, *Emerging Research in Computing, Information, Communication and Applications*, Lecture Notes in Electrical Engineering, Volume 928, pp 161-174
- [10] Ning Sun, Adam Kopper, Rasika Karkare, Randy Paffenroth, Diran Apelian, Machine learning pathway for harnessing knowledge and data in material processing, *International Journal of Metalcasting* (2021) Volume 15, Issue 2, pp 398-410
- [11] D. Ananthapadmanaban, Amartya Karthik, (2018) Development of an Expert System to Monitor Casting Defects in Foundries, *Advances in Manufacturing Processes*, pp 101-109
- [12] Sudesh, K., Prakash, G.R., Roshan, H.M.: Knowledge-based expert system for analysis of casting defects. (1998) *AFS Trans.* 96, 178–192
- [13] D. Ananthapadmanaban and Amartya Karthik, Development of an Expert System to Monitor Casting Defects in Foundries, (2018) *Advances in Manufacturing Processes*, Lecture Notes in Mechanical Engineering, Springer, September 2018, pp 101-109.

- [14] Katsunori I (1980) Image processing for on-line detection of welding process (Report 1). Journal of The Japan Welding Society 49(9):609–613. <https://doi.org/10.2207/qjwsw.1943.49.609>. (in Japanese)
- [15] Takaichi K, Yoichi T, Masahiro K, Junichiro M (1989) Development of real time welding control system by using image processing. Quarterly Journal of The Japan Welding Society 7–3:363– 367. <https://doi.org/10.2207/qjwsw.7.363>. (in Japanese) 3
- [16] Yoshihiro F, Tsuyoshi O, Satoru A, Setsu Y, Tatsuya O, Makoto O (2012) Development of a welding monitoring system for inprocess duality control of thick walled pipe. Welding in the World 56:15–25. <https://doi.org/10.1007/BF03321391>
- [17] Jinhee Kim<sup>1</sup> ·Hyunkyung Lee<sup>1</sup> · Young Hoan Cho., (2022) Learning design to support student-AI collaboration: perspectives of leading teachers for AI in education, Education and Information Technologies 27:6069–6104
- [18] Stephan Popenici, Sharon Kerr, (2017) Exploring the impact of artificial intelligence on teaching and learning in higher education, Research and Practice in Technology Enhanced Learning, Volume 12, Issue 22,
- [19] Uchechukwu Ajuzieogu, (2019) The Role Of Artificial Intelligence (AI) In Modern Computing and Education, Computer Education Conference, June 2019
- [20] J.E. Jones, R. Rock, (1990) Application of Artificial Intelligence Techniques to Welding, [Materials Processing: Theory and Practices, Volume 8](#), 1990, Pages 337-361
- [21] Lee, S. S., & Kim, J. (2020). An exploratory study on student-intelligent robot teacher relationship recognized by middle school students. Journal of Digital Convergence, 18(4), 37–44.
- [22] Hassani, H., Silva, E. S., Unger, S., TajMazinani, M., & Mac Feely, S. (2020). Artificial intelligence (AI) or intelligence augmentation (IA): What is the future? Ai, 1(2), 143–155.
- [23] Zheng, N. N., Liu, Z. Y., Ren, P. J., Ma, Y. Q., Chen, S. T., Yu, S. Y., Xue, J. R., Chen, B. D., & Rui, Y. (2017). From artificial intelligence to augmented intelligence. IEEE Multimedia, 24(1), 4–5
- [24] UNESCO. (2021). AI and education: Guidance for policy-makers. UNESCO Publishing
- [25] Mehrnaz Fahimirad, (2018) A Review on Application of Artificial Intelligence in Teaching and Learning in Educational Contexts, International Journal of Learning and Development, Vol. 8, No. 4,
- [26] Carla da Silva Santana<sup>a,b,\*</sup>, Valeria Meirelles Carrilho<sup>b</sup> and Valeria Sousa de Andrade (2006) Reflections about learning and teaching assistive technology in Brazil, Technology and Disability, 21pp 1-6
- [27] V.V. Subramanyam, K. Swathi, (2018) Artificial Intelligence an International Conference on Improved Access to Distance Higher Education Focus on Underserved Communities and Uncovered Regions, Kakatiya University, Warangal, Telangana, India 11-12 Aug, and its Implications in Education,