

# Developing 4IR Engineering Entrepreneurial Skills in Polytechnic Students. A Conceptual Framework



Idris Mohammed Abdullahi, Mohammed Khata bin Jabor, Terungwa Stephen Akor

**Abstract:** *The Fourth Industrial Revolution (4IR) which is technological driven has brought a lot of opportunities those with entrepreneurial mindset as most of the skills demanded in the 4IR are entrepreneurial. This calls approaches that can lead to the development of engineering entrepreneurs that can drive the 4IR. To this effect, this study explored experts' opinions on the most relevant entrepreneurial skills for the 4IR engineers as well as the best teaching methods to be adopted for the teaching of entrepreneurship education in Nigerian polytechnics. A two-round Delphi interview was used to arrive at 19 entrepreneurial skills with experts' consensus of  $W^a = 0.821$  and 8 innovative teaching methods with experts' consensus of  $W^a = 0.925$ . The results from the findings were used to develop a conceptual framework for the development of 4IR Entrepreneurial skills.*

**Keywords:** *Fourth Industrial Revolution, Engineering Entrepreneurs, Entrepreneurial Skills, Entrepreneurship Education, Polytechnic Students*

## I. INTRODUCTION

The emergence of the fourth industrial revolution (4IR) has presented numerous benefits, opportunities as well as challenges at a higher frequency more than any other previous revolution. The 4IR is a sharp contrast from the previous revolutions because, unlike the previous revolutions where technology replaced skilled workers, technologies of the 4IR complement workers with high skills while replacing workers with low skills. The chances of any economy to participate in manufacturing and production in the 4IR depends on the availability of relevant skills. As a result of the replacement of low skilled workers in manufacturing, the chances are that over 66% of developing countries' jobs are at risk.

This shows that most countries in Africa are at the risk of losing around 44 - 50% of their jobs to automation [1]

The era of 4IR has brought a fundamental shift across the industries in areas of design, production, sales, marketing, and delivery systems.

According to [2], 4IR has four major characteristics: Homo sapiens developed into "phono sapiens" with most industrial business activities dominated by smartphones; creation of knowledge is with the collection, categorization, and analysis of big data sets; software's in artificial intelligence now compete with human intelligence where AI robots replace many human routine jobs and; Business platforms get more popular with mass customization and personalized production being realized.

Entrepreneurship education is the attainment of skills, knowledge and attitude that allows learners to comprehend the challenges of life in various forms and systematically provide solutions such challenges [1]. The main aim of entrepreneurship education is to enhance innovation, creativity, and self-employment in learners through the inculcation of entrepreneurial competencies, knowledge and attitude. It also aims at enabling learners to acquire entrepreneurial abilities and skills for self-employment and self-reliance. Entrepreneurial abilities cover the capacity to create opportunities and resources, take a risk, cope with change, manifest undismayed allegiance to goal and usually act with an innovative mindset. These happen to be among the most demanded skills in the 4IR.

## II. LITERATURE REVIEW

Considering the skills demand by the 4IR, it is obvious that entrepreneurs stand to control the 4IR, hence the need the develop entrepreneurial education and all levels of education.

### A. The 4IR Skills

The fourth industrial revolution is innovation disruptive powered revolution that is beyond technology-driven evolution with the core aim of positively impacting all sectors of the society. Unlike the previous revolutions where education changed with focus on standardized learning methods like McGuffey reader in the first industrial revolution, mass production and standardized testing in the second industrial revolution and service-oriented learning in the third industrial revolution, the 4IR brings technologies that blur the borders between the biological, digital and the physical world. [3].

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Innovative disruptions have paved the way for advanced education where conventional methods of instruction in the polytechnics and universities are carried out. Innovative methods have emerged with a shift of focus from teaching modes to learning modes with the constant development of alternative curriculums. These disruptive innovations also have changed the way of doing business without of the box thinking [4]. This has led to continuous creation of new markets and the definition of new products. We are now in an era that features automation, artificial intelligence, genetic engineering and robotics with the emergence of ethical concerns. There have been lots of debates in genetic engineering on the utilization of research technologies and tools with the desire for prevention of genetic diseases with genetic engineering [5]. With the infusion of machine learning and AI, more autonomous and smarter robots are evolving however, they still lack the moral reasoning capacity as well as essential features thus, limiting their ability to ethical decisions in situations that demand complex negotiation. This raises a critical question of whose moral standard robot should inherit considering the variations in moral values among individuals, religions, nations, and ideology boundaries. The uncertainty on the choice of moral framework to be adopted underlies the challenge and limitations associated with the moral values of AI[6].

In the 4IR, creativity has become among the three most demanding skills by employers. With the roll-down of new technologies, products and ways of carrying out work tasks, employees are expected to become highly creative to fit into the drastic changes. Though robots may help to make tasks faster and easier, they lack creativity compared with humans. This relegates flexibility and negotiation which use to top the list of skills in 2015 as machines will utilize mass data to make decisions by 2020. According to a survey carried out by the World Economic Forum's Global Agenda Council on society and software's future shows that AI machines are expected to become part of companies' board of directors of companies by 2026. Similarly, emotional intelligence is likely to replace active learning which is now on top of the list of top 10 core skills.

### B. Entrepreneurship Education

Entrepreneurship education is the capacity and willingness to design, launch, run, and manage a new business venture along with any of its risks to make a profit. In other words, it is a process of developing entrepreneurs who can design, launch, run and manage new business ventures from small scale, start-up companies, product offers, service or process to solve particular problems.

Entrepreneurship education covers every activity aimed at fostering entrepreneurial mindset, skills and attitudes as well as a variety of aspects like start-ups, generation and innovation [7]. The pioneer of entrepreneurship education was Shigeru Fijii, who initiated this educational field in 1938 at the University of Kobe Japan. In 1940, business management courses began to emerge and were introduced in entrepreneurship in the Harvard Business School USA in 1947. This phenomenon gained more universal recognition within half a century [8]. Now, every American Assembly of College Schools of Business (AACSB) takes taught courses

in entrepreneurship education with considerable world-wide growth [4].

Considering the growth rate in the number of institutions offering courses in entrepreneurship education, issues now abound on opinions on whether entrepreneurship can be taught or its from birth. Arguments still exist that entrepreneurship cannot be taught since it is a matter of psychological and personality characteristics. This argument is usually hinged on the illusion that that temperaments and talents cannot be taught [9] however, there are emerging facts that entrepreneurship can be taught [7]. This can be justified when compared with many professions as it is indisputable that professions like law, medicine, and engineering are taught although there are people that are naturally talented in these fields while others are not. This argument is commensurate with entrepreneurship education and entrepreneurs [10]. As stated by [11], entrepreneurship teaching is both arts and science with the later relating to functional skills that are required to a start-up business, while the formal deals with creativity in entrepreneurship, both of which are not explicitly teachable. Entrepreneurship educators now are of unanimous arguments on the need to shift emphasis to creative and artistic teaching of entrepreneurship as against the scientific approach. It has also been admitted that entrepreneurship education activates creative, perceptual and artistic aspects of entrepreneurship despite the scientific dimension of it [7].

Entrepreneurship education addresses a diverse range of objectives, audience, content and teaching methods [12]. Previous studies have identified the most cited objectives of entrepreneurship education as acquisition of relevant entrepreneurship knowledge, acquisition of skills in techniques application, business situation analysis and synthesis, identification and stimulation of entrepreneurial drive, skills and talents, neutralization of risk-averse bias of various techniques of analysis, development of support and empathy for the unapparelled aspect of entrepreneurship, revision of attitude towards change, to promote emerging start-ups and other entrepreneurial ventures, to stir the 'affective socialization element' [8]. Entrepreneurship education can be categorized into three main objectives, these include the creation of awareness, teaching methods, tools and the effective situation management and project supporting bearers [5]. Entrepreneurship education generally aims at increasing the awareness of entrepreneurship as a career option, and heighten the assimilation of the processes involved in the initiation and management of new business enterprises [8].

Various systems of education create awareness on alternative vocational choices and diversify the individuals' horizon, equip them with mental tools that enable them to perceive and develop entrepreneurial opportunities. It is worthy of note that systems of education have the potentials of developing qualities in people that are paramount in entrepreneurship thus enabling learners to see new opportunities to create new career options, develop favorable and positive attitudes towards entrepreneurial development. Entrepreneurship education constitutes a requisite instrument the development of regional entrepreneurial culture.

Entrepreneurial education is capable of contributing to image improvement and spotlights entrepreneurs' role in the society in addition to development of entrepreneurial spirit. [13].

**C. Engineering and Entrepreneurship Education**

There is a continues rise in demand for professional engineers and thousands of new engineering jobs are expected to emerge by 2026 as speculated by the Bureau of Labour Statistics [14]. As the more engineers entering the field with the evolving industry, there is a parallel rise in job opportunities as well as the employers' needs. Work activities in technical aspects are being automated as a result of innovations like learning and artificial intelligence. However, many skills like people management, decision making,

negotiation, critical thinking, and innovation are still automatable. This report confirmed by research from the World Economic Forum which estimated that 35% of the existing important skills will change by 2020 [15]. According to the report, the top 10 competencies to be demanded by employers include: critical thinking, complex problem-solving, coordinating with others, people management, judgment and decision-making, emotional intelligence, negotiation, cognitive flexibility, and service orientation. To remain connective and advance in career, engineers need beyond the acquisition technical skills and to meet the demand of the job, they are required to round out their existing experience by adding business and entrepreneurial skills set [16].

**Table I:** Experts suggestion on the most relevant 4IR Entrepreneurial Skills

| Code | Skills                         | Experts | Code | Skills                            | Experts |
|------|--------------------------------|---------|------|-----------------------------------|---------|
| PSS  | Problem-solving skills         | 23      | OGS  | Organisation skills               | 31      |
| FMS  | Financial Management skills    | 17      | IPS  | Interpersonal skills              | 24      |
| CTS  | Critical thinking skills       | 29      | LS   | leadership skills                 | 27      |
| EI   | Emotional Intelligence         | 25      | SDS  | Self-directed thinking            | 19      |
| RIR  | Research/Information retrieval | 19      | LLL  | Life-long learning                | 22      |
| CIS  | Creativity/Innovation skills   | 22      | TMS  | Time management skills            | 32      |
| TWS  | Team working skills            | 27      | RM   | Resources management              | 37      |
| CS   | Communication skills           | 23      | PPS  | Public Presentation skills        | 35      |
| ALS  | Active learning skills         | 18      | CES  | Critical evaluation of literature | 29      |
| RS   | Reasoning skills               | 19      | RCV  | Respect for colleagues' views     | 28      |

With the continues disruption of the industry by emerging technologies, the race is left for engineers with the capacity to spot new opportunities and evaluate their ideas to fit in. considering today's complex advancement in the global business world, companies cannot continue to approach issues in the manner, and pivotal role of engineers in problem solving plays in [17]. It is engineers' responsibility to spot the emerging challenges that are important and need solutions. Engineers develop and build products/services that directly affect the society and as such, it is necessary to approach each problem with ethical considerations by doing the right thing for the business. The acquisition of business and entrepreneurial skills can equip engineers to meet the changing career demand and gain competitive edge.

**D. Entrepreneurship Education Teaching Methods**

Formal lectures, case studies, web-based learning, video recording, seminar, guest speaking, action learning, individual written reports, group project, individual presentation, and group discussion are among the most popular methods of teaching in Nigeria. The study by [18] identified the most popular methods of teaching entrepreneurship education as case studies, lectures and business plan creation. However, [8], put a varied argument that, entrepreneurship education can be taught based on the chosen or given objectives. For instance, seminars, lectures and media are the most appropriate methods of teaching when entrepreneurial education is to enhance the assimilation of the concept. The effectiveness of these methods is due to their abilities to transmit the relevant knowledge to a larger audience within a relatively given period. However, trainings like participatory learning are applied when the objective aimed at equipping learners with the needed entrepreneurial

skills that are directly applicable to the work environment. Lastly, if the aim of education is to produce entrepreneurs, the best approach is business simulation or role playing which helps in fat-tracking experiments in controlled environment [19].

Teaching methods are mostly categorized by authors into two categories, namely "traditional methods" which are usually lectures and "innovative methods" which are students' centred and action-based [20], [21]. According to [22], active methods make the teachers facilitators as against their role as instructors in the traditional methods thereby applying and controlling methods that lead the learners to self-discovery. This benefits the learning process as against the conventional methods of teaching like case studies, group discussion and lectures. These methods, according to [23] are less effective at imparting entrepreneurial skills due to their passive nature. [24] observed, instructors' reliance on lecture-based methods is due to the ease of the usage and cost effectiveness. The other usual methods that vary slightly from the previous ones are business plan creation, filming and video, project works, role models guest speakers, simulations and computer-based business. Others include, study visits, presentations, setting of business ventures, games and competitions. These later methods of teaching are referred to as "active methods" and are fund mor appropriate for developing entrepreneurial skills among learners. [13]. It can be seen from various studies that traditional teaching methods are not effective in promoting entrepreneurial attributes.

# Developing 4IR Engineering Entrepreneurial Skills in Polytechnic Students. A Conceptual Framework

These methods are not only boring but also make learners entrepreneurs instead of making them entrepreneurs. dormant participants thus, making them employees under

**Table II:** Experts' suggestion of the Most Relevant Teaching Methods for 4IR Entrepreneurial Skills

| Code  | Teaching Method                         | Exprts |
|-------|---|--------|
| FCR   | Flipped Classroom                       | 27     |
| PjBL  | Project-Based Learning                  | 32     |
| CPL   | Cooperative Learning                    | 35     |
| GAM   | Gamification                            | 27     |
| PbBL  | Problem-Based Learning                  | 31     |
| DT    | Design Thinking                         | 22     |
| CBL   | Competency-Based Learning               | 37     |
| SL    | Service Learning                        | 31     |
| POPBL | Problem-Oriented Project-Based Learning | 32     |
| TBL   | Thinking-Based Learning                 | 29     |

The observed limitations of the existing teaching methods confirm [25] observation that though most teachers of entrepreneurship education relate their course contents with emerging venture creation, the result is usually the teaching of entrepreneurship without necessarily imparting the knowledge. By implication, the best method of entrepreneurship education through apprenticeship-like learning methods while traditional methods can be complemented to give learners commercial underpinnings of entrepreneurial actions. By, doing something practical and having an opportunity to investigate, question, discuss and converse with real-world entrepreneurs gives both knowledge and skills and also stimulates attitudes. However, in a pragmatic, since most of the advocated active/action-based teaching methods are costly and somehow may not align to the conventional institutional system of teaching and awarding [7]

The teachers' major responsibilities are to provide cognitive knowledge on entrepreneurship and business planning, to guide the learners to find and test business innovations, and assess business opportunities and to consult teamwork and business plan writing. The learners are expected to appreciate the importance of proposing and preparing a business plan, gain an insight of the Business Plan structure and process of preparation, and acquire some practice in developing a business plan based on their business idea. Knowledge on how to implement a business idea, the experience of business planning and information on the process of starting up an enterprise should motivate learners to think about setting up their own business and as a result, bring more of them to entrepreneurship [11].

While appreciating the necessity and importance of education in shaping our culture and destiny, it should equally be known that a serious deviation is needed from the existing traditional way of doing things especially the approach of training and method of teaching in our institutions. There is need therefore to refocus on entrepreneurial education at the polytechnics level. This should target alternative methods of teaching that will inculcate, harness and develop the

entrepreneurial career of the younger generations and also enhance their potentiality towards entrepreneurial skills which will consequently foster economic growth and development leading to employment and poverty alleviation. Entrepreneurship development through education has been receiving attention nationally [25]

Several attempts have been made through researches, mounting of entrepreneurship courses, programmes in both institutions of learning and entrepreneurship research centres to develop both entrepreneurial spirit and culture among the people [10]. However, the effort has to be intensified to mobilize and enhance entrepreneurial activity which will consequently benefit the individuals, government, and the society at large. The issue of poverty eradication has been a top priority of many governments and institutions especially in developing countries where extreme poverty is conspicuously pandemic [10], [25].

## III. RESEARCH QUESTIONS

The following research questions were used to guide the Study:

- i. What are the most relevant entrepreneurial skills to be developed by engineers in the 4IR?
- ii. What are the best teaching methods to be employed for the development of 4IR entrepreneurial skills in engineering?

## IV. METHODOLOGY

To answer the above questions, a two-round Delphi interview was carried out on 58 lecturers purposefully sampled from a population of 136 lecturers. Their responses were coded using NVivo 12 software while Kendall's Coefficient was applied to determine the level of consensus using SPSS 25. The results were used to develop a conceptual framework for the development of 4IR entrepreneurial skills among polytechnic students.

**V. RESULTS & FINDINGS**

To obtain information from the experts, experts’ opinions on the most relevant entrepreneurial skills for the 4IR and the correspondent teaching methods were sought using open-ended interviews in the first round of Delphi.

The results from the first and second rounds of Delphi interview are as follows:

**A. Delphi Round 1 Section 1: Experts’ suggestion of the Most Relevant 4IR Entrepreneurial Skills.**

To determine the most relevant 4IR entrepreneurial skills, open-ended questions were used to get experts opinions and the results were coded using NVivo 12 and tabulated as shown in Table I.

Relevant to 5 = Highly Relevant. The questionnaire was distributed to the 58 experts to determine their level of consensus using Kendall’s coefficient ( $W^a$ ). The experts unanimously on all the skills except critical evaluation of literature which has a mean acceptance of less than 3.000. there was a high level of consensus with a  $W^a = 0.821$  as shown in Table III.

**D. Delphi Round 2 Section 2: Experts Consensus on the Most Effective Teaching Methods for 4IR Entrepreneurial Skills**

To determine the most effective teaching methods to be utilized for the development of 4IR entrepreneurial skills, all the experts’ responses in Table II were entered a 5-point Likert’s type scale and redistributed to the 58 experts to arrive a unanimous consensus. Apart from flipped classroom and

**Table III: Experts Consensus on the Most Relevant 4IR Entrepreneurial Skills**

| Skills                            | N  | Mean   | S.D    | Min  | Max  | $W^a$ |
|-----------------------------------|----|--------|--------|------|------|-------|
| Problem-solving skills            | 58 | 4.5833 | .51493 | 4.00 | 5.00 | 0.821 |
| Financial Management Skills       | 58 | 4.6667 | .49237 | 4.00 | 5.00 |       |
| Critical thinking skills          | 58 | 4.6667 | .49237 | 4.00 | 5.00 |       |
| Emotional Intelligence            | 58 | 4.5833 | .51493 | 4.00 | 5.00 |       |
| Research/Information retrieval    | 58 | 4.5833 | .51493 | 4.00 | 5.00 |       |
| Creativity/Innovation skills      | 58 | 4.8333 | .71774 | 4.00 | 5.00 |       |
| Team working skills               | 58 | 4.6667 | .77850 | 4.00 | 5.00 |       |
| Communication skills              | 58 | 4.6667 | .65134 | 4.00 | 5.00 |       |
| Active learning skills            | 58 | 4.5833 | .51493 | 4.00 | 5.00 |       |
| Reasoning skills                  | 58 | 4.6667 | .49237 | 4.00 | 5.00 |       |
| Organisation skills               | 58 | 4.6667 | .49237 | 4.00 | 5.00 |       |
| Interpersonal skills              | 58 | 4.5833 | .51493 | 4.00 | 5.00 |       |
| leadership skills                 | 58 | 4.5833 | .51493 | 4.00 | 5.00 |       |
| Self-directed thinking            | 58 | 4.8333 | .71774 | 4.00 | 5.00 |       |
| Life-long learning                | 58 | 4.5833 | .51493 | 4.00 | 5.00 |       |
| Time management skills            | 58 | 4.8333 | .71774 | 4.00 | 5.00 |       |
| Resources management              | 58 | 4.3427 | .77850 | 4.00 | 5.00 |       |
| Public Presentation skills        | 58 | 4.6667 | .65134 | 4.00 | 5.00 |       |
| Critical evaluation of literature | 58 | 1.5833 | .51493 | 1.00 | 3.00 |       |
| Respect for colleagues’ views     | 58 | 4.6574 | .49237 | 4.00 | 5.00 |       |

**B. Delphi Round 1 Section 2: Experts’ suggestion of the Most Relevant Teaching Methods for 4IR Entrepreneurial Skills.**

To determine the most effective teaching methods for the development of 4IR entrepreneurial skills, open-ended questions were used to get experts opinions and the results were coded using NVivo 12 and tabulated as shown in Table II.

**C. Delphi Round 2 Section 1: Experts Consensus on the most Relevant 4IR Entrepreneurial Skills**

To arrive at the most relevant entrepreneurial skills for the 4IR, all the response from the 58 experts were entered on a 5-point Likert’s type scale with a continuum of 1 = Not

gamification which have means of less than 3.000, all the other teaching methods were considered as effective the development of 4IR entrepreneurial skills. The experts’ level of consensus was high with a  $W^a = 0.925$  as shown in Table IV.

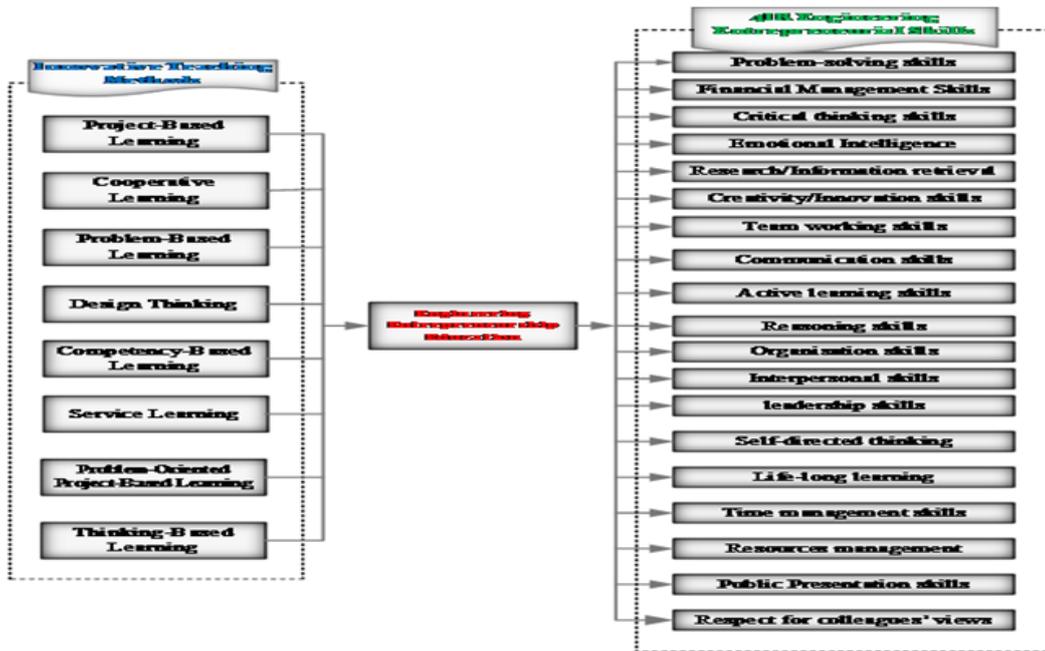


Fig. I: 4ir Entrepreneurial Skills Development Conceptual Framework

Table IV: Experts Consensus on the Most Effective Teaching Methods for 4IR Entrepreneurial Skills

| Teaching Method                         | N  | Mean   | S.D    | Min  | Max  | W <sup>a</sup> |
|---|----|--------|--------|------|------|----------------|
| Flipped Classroom                       | 58 | 2.5833 | .51493 | 1.00 | 4.00 | 0.925          |
| Project-Based Learning                  | 58 | 4.6667 | .49237 | 4.00 | 5.00 |                |
| Cooperative Learning                    | 58 | 4.6347 | .48567 | 4.00 | 5.00 |                |
| Gamification                            | 58 | 2.6821 | .52671 | 1.00 | 4.00 |                |
| Problem-Based Learning                  | 58 | 4.6667 | .49237 | 4.00 | 5.00 |                |
| Design Thinking                         | 58 | 4.5000 | .52223 | 4.00 | 5.00 |                |
| Competency-Based Learning               | 58 | 4.3333 | .46872 | 4.00 | 5.00 |                |
| Service Learning                        | 58 | 4.5833 | .51493 | 4.00 | 5.00 |                |
| Problem-Oriented Project-Based Learning | 58 | 4.7431 | .49437 | 4.00 | 5.00 |                |
| Thinking-Based Learning                 | 58 | 4.6672 | .45873 | 4.00 | 5.00 |                |

IV. 4IR ENTREPRENEURIAL SKILLS DEVELOPMENT CONCEPTUAL FRAMEWORK

The Conceptual framework as shown in Figure I according to experts' recommendations shows that the best method of developing the desired entrepreneurial skills among polytechnic students is the utilization of innovative student-centred teaching and learning approaches. The experts are optimistic that, the use of student-centred teaching and learning methods like Problem-Based Learning, Project-Based Learning, Problem-Oriented Project-Based Learning, Thinking-Based Learning, Service Learning, Competency-Based Learning, Design Thinking, and Corporative Learning have the potentials of developing the entrepreneurial skills for the 4IR. The experts unanimously agreed that Problem-solving skills, Financial Management Skills, Critical thinking skills, Group dynamics, Research/Information retrieval, Creativity/Innovation skills, Team working skills, Communication skills, Active learning

skills, Reasoning skills, Organisation skills, Interpersonal skills, leadership skills, Self-directed thinking, Life-long learning, Time management skills, Resources management, Public Presentation skills, and Respect for colleagues' views are the most relevant skills to be developed by entrepreneurs in the 4IR,

VI. DISCUSSION & CONCLUSION

Considering the drastic changes and contrast between the 4IR and the previous industrial revolutions, it is obvious that innovative entrepreneurs stand to excel in this revolution and the best way out is revisiting the system of education. To this effect, this study aimed at developing a conceptual framework for the development of 4IR entrepreneurial skills among Polytechnic students.

The findings from experts through a Delphi interview revealed that the use of innovative and student-centred teaching methods like Problem-Based Learning, Project-Based Learning, Problem-Oriented Project-Based Learning, Thinking-Based Learning, Service Learning, Competency-Based Learning, Design Thinking, and Corporative Learning have the potentials of developing the entrepreneurial skills for the 4IR.

## REFERENCES

1. W. Naudé, "Entrepreneurship, Education and the Fourth Industrial Revolution in Africa," no. 10855, pp. 1–22, 2017.
2. A. D. Maynard, "Navigating the fourth industrial revolution," *Nat. Nanotechnol.*, vol. 10, no. 12, pp. 1005–1006, 2015.
3. M. Xu, J. M. David, and S. H. Kim, "The fourth industrial revolution: Opportunities and challenges," *Int. J. Financ. Res.*, vol. 9, no. 2, pp. 90–95, 2018.
4. J. Wood et al., "ASEAN 4.0: What does the Fourth Industrial Revolution mean for regional economic integration?," 2017.
5. S. Levin, "World Economic Forum and the Fourth Industrial Revolution in South Africa," 2018.
6. B. Xing and T. Marwala, "Implications of the Fourth Industrial Age on Higher Education," *ResearchGate*, no. April, pp. 2–9, 2017.
7. W. E. Ekpiken and G. U. Ukpabio, "Entrepreneurship Education, Job Creation for Graduate Employment in South-South Geopolitical Zone of Nigeria," *Br. J. Educ.*, vol. 3, no. 23, pp. 23–31, 2015.
8. K. J. Israel and D. R. Johnmark, "Entrepreneurial Mind-Set Among Female University Students :," *Chinese Bus. Rev.*, vol. 13, no. 5, pp. 320–332, 2014.
9. P. Shank, "The Fourth Industrial Revolution - What Happens With Employment," *Assoc. Talent Development*, pp. 1–11, 2016.
10. A. O. Sofoluwe, M. O. Shokunbi, L. Raimi, and T. Ajewole, "Entrepreneurship Education as a Strategy for boosting Human Capital Development and Employability in Nigeria: Issues, Prospects, Challenges and Solutions," vol. 3, no. 1, pp. 25–50, 2013.
11. S. I. Dugguh and D. Ph, "Entrepreneurship and Small Business : Strategic Approach to Alleviating Poverty and Corruption in Nigeria," *GSTF J. Bus. Rev. Vol.3 No.1, Novemb.*, vol. 3, no. 1, pp. 57–66, 2013.
12. B. I. Ajufo, "Challenges of youth unemployment in Nigeria: Effective career guidance as a panacea," *African Res. Rev.*, vol. 7, no. 1, pp. 307–321, 2013.
13. M. H. Lee et al., "How to respond to the Fourth Industrial Revolution, or the second information technology revolution? Dynamic new combinations between technology, market, and society through open innovation," *J. Open Innov. Technol. Mark. Complex.*, vol. 4, no. 3, 2018.
14. L. Landry, "7 BUSINESS SKILLS EVERY ENGINEER NEEDS," 2018.
15. K. Baker, "The digital revolution: The impact of the Fourth Industrial Revolution on employment and education," *EDGE Digit. Revolut.*, 2016.
16. P. Swamidass, "Engineers Create Value for Investors," in *Engineering Entrepreneurship from Idea to Business Plan*, 2016, pp. 3–10.
17. V. Souitaris, S. Zerbinati, and A. Al-Laham, "Do entrepreneurship programmes raise entrepreneurial intention of science and engineering students? The effect of learning, inspiration and resources," *J. Bus. Ventur.*, vol. 22, no. 4, pp. 566–591, 2007.
18. T. S. Akor, K. Subari, H. Jambari, M. Khair, and I. R. Onyilo, "Engineering and Related Programs ' Teaching Methods in Nigeria," no. 2, 2019.
19. D. Steward and T. T. H. Wan, "The Role of Simulation and Modeling in Disaster Management," *Springer Sci. Media, LLC* 2007, pp. 125–130, 2007.
20. M. Mamdani, "A DELPHI TECHNIQUE IN PROPOSING A CONCEPTUAL POSTMODERNISM," no. January, 2013.
21. M. Li and A. Faghri, "Applying Problem-Oriented and Project-Based Learning in a Transportation Engineering Course," *J. Prof. Issues Eng. Educ. Pract.*, vol. 142, no. 3, p. 04016002, 2016.
22. M. Gao, "Institutional Repository A theoretical model for the effectiveness of project-based learning in engineering design education," 2012.
23. S. Aloraini, "The impact of using multimedia on students' academic achievement in the College of Education at King Saud University," J.

- King Saud Univ. - Lang. Transl., vol. 24, no. 2, pp. 75–82, 2012.
24. H. Roessingh and W. Chambers, "Project-Based Learning and Pedagogy in Teacher Preparation: Staking Out the Theoretical Mid-Ground," *Int. J. Teach. Learn. High. Educ.*, vol. 23, no. 1, pp. 60–71, 2011.
  25. I. E. Nkang, "Re-Engineering Entrepreneurial Education For Employment and Poverty Alleviation In The Niger Delta Region of Nigeria," vol. 4, no. 2, pp. 88–95, 2013.

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