ISSN: 3043-467X



STEAM EDUCATION AND SUSTAINABLE DEVELOPMENT GOALS IN ANAMBRA STATE: TEACHERS' PERCEPTIONS FROM AN ADULT EDUCATION PERSPECTIVE

By

[1]**Anthony Ahuruezenma Apiti** (PhD)
aa.apiti@unizik.edu.ng
Phone: 08063320590

[1*]**Obiageli Chinyelu Chukwuemerie** (PhD)
oc.chukwuemerie@unizik.edu.ng
Phone: 08037728499

Cecilia Oby Nwoye (PhD)
coo.nwoye@unizik.edu.ng
08035158116

[1]*Department of Adult and Continuing Education, Faculty of Education, Nnamdi Azikiwe University Awka*
[*]Corresponding Author: oc.chukwuemerie@unizik.edu.ng

Abstract

This study examined teachers' perceptions of STEAM education programme and Sustainable Development Goals (SDGs) from an adult education perspective in Anambra State. The study explored how teachers, as adult learners and professional practitioners, perceive STEAM education in relation to poverty reduction (SDG 1), quality education (SDG 4), and gender equality (SDG 5). Three research questions guided the study. The descriptive survey research design was adopted for the study. The population consisted of 14,546 public and public-mission pre-tertiary school teachers across the 21 Local Government Areas of Anambra State. A sample size of 588 respondents was selected using the Taro Yamane formula. Data were collected using a structured questionnaire titled "Teachers' Perception of STEAM Education Effectiveness and Sustainable Development Goals Questionnaire" (TPSTEAMESDGQ). The instrument was validated by two

experts, while reliability was established using Cronbach Alpha with coefficients of 0.78, 0.74, and 0.89 for the three clusters respectively. Mean and standard deviation were used to answer the research questions. Findings revealed that teachers perceived STEAM education as effective in reducing poverty through skill acquisition, entrepreneurship, and employability development. The findings also indicated that STEAM education positively supports quality education through experiential learning, creativity, collaboration, and problem-solving competencies. Furthermore, teachers perceived STEAM education as capable of promoting gender equality in educational participation and learning outcomes. The study concluded that STEAM education aligns with the objectives of adult education by promoting lifelong learning, empowerment, innovation, and sustainable community development. The study recommended continuous professional development for teachers, establishment of community-based STEAM learning centres, and increased investment in technology-driven educational practices.

Keywords: Adult Education, STEAM Education, Sustainable Development Goals, Lifelong Learning, Teachers' Perception, Sustainable Development

Introduction

The increasing complexity of the twenty-first century has continued to reshape expectations from educational systems globally. Rapid technological advancement, globalization, climate change, unemployment, and evolving labour market demands have increased the pressure on educational institutions to produce learners who are innovative, adaptable, and capable of solving practical societal problems. According to UNESCO (2021), modern education systems are expected to equip learners with competencies that support sustainable living, creativity, collaboration, critical thinking, and lifelong learning. Similarly, OECD (2021) emphasized that education must move beyond memorization and passive learning toward innovative approaches that encourage practical engagement and problem-solving. Consequently, educational transformation has become necessary for nations seeking sustainable development and global competitiveness.

Within the framework of adult education, learning is regarded as a lifelong process that enables individuals to continuously adapt to social, technological, and economic changes. Adult education promotes functional knowledge, employability, empowerment, and sustainable community participation. Knowles et al. (2020) argued that adult learners are motivated when learning experiences are practical, relevant, and connected to real-life challenges. Similarly, Freire (1970) maintained that education should empower individuals to critically understand and transform their social realities. In this regard, educational systems are increasingly expected to provide innovative learning opportunities that prepare individuals for productive participation in society.

One educational approach receiving increasing global attention is STEAM education, which integrates Science, Technology, Engineering, Arts, and Mathematics into a unified interdisciplinary learning framework. STEAM education promotes creativity, inquiry-based learning, communication, innovation, collaboration, and problem-solving competencies necessary

for modern society. Perignat and Katz-Buonincontro (2019) explained that STEAM education encourages interdisciplinary learning experiences that enable learners to connect theoretical knowledge with practical applications. Khine and Areepattamannil (2019) further noted that integrating arts into STEM education enhances creativity, imagination, and collaborative thinking among learners. Likewise, Hsiao and Su (2021) observed that STEAM education creates opportunities for learners to develop innovative and sustainable solutions to societal challenges.

The relevance of STEAM education has become increasingly significant within the context of the Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 4 (Quality Education), and SDG 5 (Gender Equality). The SDGs introduced by the United Nations in 2015 provide a global framework for addressing poverty, inequality, unemployment, environmental degradation, and educational challenges. UNESCO (2021) emphasized that education remains central to achieving all Sustainable Development Goals because it empowers individuals with the knowledge and competencies required for national development. Leal Filho et al. (2019) also explained that sustainable education requires innovative instructional approaches capable of promoting critical thinking, creativity, responsible citizenship, and environmental consciousness.

STEAM education aligns closely with the objectives of adult education because it promotes experiential learning, innovation, entrepreneurship, and practical problem-solving competencies required for lifelong learning and sustainable livelihood. Through hands-on learning experiences and collaborative engagement, learners are equipped with functional skills relevant to employability, self-reliance, and community transformation. Acosta Castellanos and Queiruga-Dios (2022) maintained that STEAM education contributes significantly to sustainable development because it equips learners with competencies needed to address social, economic, and environmental challenges.

In Anambra State, the educational system continues to face several challenges that undermine effective teaching and learning outcomes. Despite efforts by government and educational stakeholders, many schools still struggle with inadequate infrastructure, shortage of instructional materials, overcrowded classrooms, and insufficient access to technological resources. Anekwe (2021) observed that poor educational management and inadequate teacher preparation continue to affect the quality of education in South-East Nigeria. Similarly, the World Bank (2018) reported that many Nigerian schools operate within systems that are unable to adequately support learner-centred teaching or equip students with employable skills required in modern society.

Another major challenge confronting schools in Anambra State is the continued dependence on rote learning and memorization as dominant instructional approaches. In many schools, classroom teaching remains examination-oriented with limited opportunities for creativity, experimentation, collaboration, and practical engagement. OECD (2021) explained that traditional teacher-centred approaches often restrict learners' ability to develop innovation and independent reasoning skills. Consequently, there is increasing recognition that educational transformation requires innovative

instructional approaches capable of moving learners beyond passive learning toward active problem-solving and practical engagement.

Teachers occupy a central position in the successful implementation of STEAM education and the realization of sustainable development goals within schools and communities. As adult learners and professional practitioners, teachers influence how educational innovations are understood, accepted, and implemented in classroom practice. Darling-Hammond et al. (2020) asserted that teachers' beliefs and instructional practices significantly shape students' learning experiences and educational outcomes. Likewise, Thibaut et al. (2018) explained that successful implementation of interdisciplinary approaches such as STEAM depends largely on teachers' understanding, readiness, confidence, and willingness to integrate innovative teaching strategies into classroom instruction.

Despite increasing global discussions on educational innovation and sustainable development, empirical evidence on teachers' perceptions of STEAM education and its relationship with Sustainable Development Goals in Anambra State remains limited. Furthermore, many teachers still have inadequate opportunities for continuous professional development in STEAM-related pedagogies. This situation may weaken the capacity of schools to equip learners with competencies required for employability, lifelong learning, poverty reduction, and sustainable community participation. It is against this background that this study examined teachers' perceptions of STEAM education and Sustainable Development Goals from an adult education perspective in Anambra State.

Statement of the Problem

The integration of STEAM education with the Sustainable Development Goals has become increasingly important in addressing global and local developmental challenges. Although STEAM education possesses enormous potential for improving educational outcomes, innovation, employability, and sustainable development, there remains limited empirical evidence regarding teachers' perceptions of its effectiveness in promoting SDG 1 (No Poverty), SDG 4 (Quality Education), and SDG 5 (Gender Equality) in Anambra State.

The situation is further complicated by persistent educational challenges such as inadequate infrastructure, insufficient teacher training, poor access to technology, and overdependence on traditional teacher-centred instructional methods. Many teachers in Anambra State still experience limited opportunities for continuous professional development in STEAM-related pedagogies. This may reduce their capacity to implement innovative teaching strategies capable of preparing learners with practical competencies necessary for lifelong learning, entrepreneurship, sustainable livelihood, and community participation.

Within the context of adult education, teachers are regarded as adult professionals whose perceptions and experiences significantly influence educational innovation and sustainable social transformation. However, inadequate understanding of teachers' perceptions of STEAM education

may hinder effective educational planning, curriculum implementation, and achievement of sustainable development goals. Therefore, the study sought to examine teachers' perceptions of STEAM education and Sustainable Development Goals from an adult education perspective in Anambra State.

Specific Objectives

Specifically, the study determined:

1. Teachers' perception of STEAM education effectiveness in reducing poverty (SDG 1) in public and public-mission pre-tertiary schools in Anambra State.
2. Teachers' perception of STEAM education influence on quality education (SDG 4) in public and public-mission pre-tertiary schools in Anambra State.

3. The extent to which teachers perceive STEAM education as promoting gender equality in educational outcomes (SDG 5) in public and public-mission pre-tertiary schools in Anambra State.

Research Questions

The following research questions guided the study:

1. What are teachers' perceptions of STEAM education effectiveness in reducing poverty (SDG 1) in public and public-mission pre-tertiary schools in Anambra State?

2. How do teachers perceive STEAM education as influencing quality education (SDG 4) in public and public-mission pre-tertiary schools in Anambra State?

3. To what extent do teachers perceive STEAM education as promoting gender equality in educational outcomes (SDG 5) in public and public-mission pre-tertiary schools in Anambra State?

Theoretical Framework

The study was hinged on two theories - Constructivist Learning Theory and Andragogy theory

Constructivist Learning Theory by Jean Piaget (1972):

Constructivist Learning Theory, pioneered by Jean Piaget (1972), posits that learners actively construct knowledge through environmental engagement and social interaction rather than passively receiving information. The theory emphasizes experiential learning, collaboration, reflection, and problem-solving. Learners construct understanding through interaction with their environment, making learning meaningful and relevant.

The theory is relevant to STEAM education because STEAM emphasizes inquiry-based learning, experimentation, creativity, collaboration, and practical application of knowledge. Constructivist learning therefore supports the development of critical thinking and innovation competencies necessary for sustainable development.

Andragogy Theory by Malcolm Knowles (1980):

The theory of Andragogy developed by Malcolm Knowles (1980) explains how adults learn and emphasizes that adult learners are self-directed, experience-based, goal-oriented, and motivated by practical relevance. Knowles et al. (2020) explained that adults learn best when learning experiences address real-life problems and encourage active participation.

While Constructivist Learning Theory sufficiently explains how knowledge is actively constructed through interaction and experience, it does not adequately address the unique characteristics, motivations, and self-directed nature of adult learners. This theoretical gap is addressed by Andragogy Theory, which specifically explains adult learning behaviour and professional learning engagement. Since teachers are adult professionals whose perceptions and practices are shaped by practical relevance, prior experiences, and opportunities for growth, Andragogy complements Constructivism by providing a stronger explanation of teachers' readiness to adopt STEAM education for sustainable development.

Methodology

The descriptive survey research design was adopted for the study. The population consisted of 14,546 public and public-mission pre-tertiary school teachers across the 21 Local Government Areas of Anambra State. A sample size of 588 respondents was selected using the Taro Yamane formula.

Data were collected using a structured questionnaire titled "Teachers' Perception of STEAM Education Effectiveness and Sustainable Development Goals Questionnaire" (TPSTEAMESDGQ), developed by the researcher. The instrument consisted of two sections. Section A contained demographic information of respondents, while Section B was divided into three clusters corresponding to the research questions.

The instrument was subjected to face validation by two experts in Adult Education and Educational Measurement and Evaluation. The reliability of the instrument was established using Cronbach Alpha, yielding coefficients of 0.78, 0.74, and 0.89 for clusters I–III respectively.

The administration of the instrument was conducted through direct administration approach. Mean and standard deviation were used to answer the research questions. A criterion means of 2.50 was adopted for decision making. Mean scores of 2.50 and above were accepted, while scores below 2.50 were rejected.

Results

Table 1: Respondents' ratings on the teachers' perception of STEAM education's effectiveness in reducing poverty (SDG 1) in public and public-mission pre-tertiary schools in Anambra State

S/N	Item statement	X	SD	Remarks
1	STEAM education equips students with problem-solving skills that can help them escape poverty.	2.94	0.50	Agree
2	Integrating STEAM into the curriculum enhances students' creativity and innovation for income-generating activities.	3.03	0.73	Agree
3	STEAM education provides practical knowledge that prepares students for self-reliance after school.	3.37	0.90	Agree
4	Exposure to STEAM projects helps students develop entrepreneurial skills relevant to reducing poverty.	2.64	0.63	Agree
5	I believe that STEAM education can bridge the gap between academic learning and real-life economic challenges.	3.15	0.73	Agree
6	STEAM-related skills (such as coding, design, and technology use) can improve students' job prospects in the future.	2.75	0.65	Agree
7	STEAM education encourages critical thinking that is useful for addressing community poverty-related issues.	2.80	0.89	Agree
8	Through STEAM, students are better prepared to pursue vocational or technical opportunities that reduce unemployment.	3.02	0.84	Agree
	Cluster Mean	**2.96**		**Agree**

The results in Table 1 indicate a strong consensus among teachers regarding the perceived effectiveness of STEAM education in reducing poverty (SDG 1) in Anambra State's schools. Individual item means, all above the midpoint of 2.50, further substantiate this agreement. Teachers particularly agree that STEAM education provides practical knowledge for self-reliance (mean 3.37) and bridges the gap between academia and real-life economic challenges (mean 3.15).

The lowest mean, for developing entrepreneurial skills (mean 2.64). The cluster means of 2.96 showed that teachers perceived STEAM education to be effective in reducing poverty (SDG 1) in public and public-mission pre-tertiary schools in Anambra State. The relatively low cluster standard deviation suggests a general uniformity in their perceptions, with minimal disagreement.

Table 2: Respondents' ratings on how teachers' perception of STEAM education influence quality education (SDG 4) in Anambra State's public and public-mission pre-tertiary schools

S/N	Item statement	X	SD	Remarks
9	STEAM education helps to improve students' understanding of core subjects like science and mathematics.	3.05	0.46	Agree
10	I perceive STEAM education as enhancing students' critical and creative thinking abilities.	3.41	0.91	Agree
11	Incorporating STEAM in the classroom promotes inclusive and equitable learning opportunities.	3.11	0.43	Agree
12	STEAM activities make learning more engaging and meaningful for students.	3.23	0.79	Agree
13	I believe STEAM education equips students with 21st-century skills needed for academic success.	3.21	0.41	Agree
14	STEAM integration helps students apply knowledge to real-life situations, thereby improving learning quality.	2.97	0.87	Agree
15	I view STEAM as a tool for reducing disparities in learning outcomes among students.	2.62	1.43	Agree
	Cluster Mean	**3.09**		**Agree**

The result in Table 2 shows that teachers generally perceive STEAM education as positively influencing quality education (SDG 4) in Anambra State's public and public-mission pre-tertiary schools. The mean scores of the items ranged from 2.62 to 3.41, all of which fall within the "Agree" category, indicating favourable perceptions. For instance, teachers strongly agreed that STEAM enhances students' critical and creative thinking abilities (Mean = 3.41, SD = 0.91) and makes

learning engaging and meaningful (Mean = 3.23, SD = 0.79). They also agreed that STEAM improves understanding of core subjects such as science and mathematics (Mean = 3.05, SD = 0.46) and equips students with 21st-century skills (Mean = 3.21, SD = 0.41). Although the lowest perception was recorded on STEAM reducing disparities in learning outcomes (Mean = 2.62, SD = 1.43), the cluster means of 3.09 summarized that teachers' perception of STEAM education influenced quality education (SDG 4) in public and public-mission pre-tertiary schools in Anambra State.

Table 3: Respondents' ratings on teachers' perception of STEAM education predict gender equality in educational outcomes (SDG 5) in public and public-mission pre-tertiary schools in Anambra State

S/N	Item statement	X	SD	Remarks
16	STEAM education provides equal learning opportunities for both male and female students.	3.16	0.60	Agree
17	I perceive that STEAM education reduces gender stereotypes in subject choices.	3.64	0.82	Agree
18	STEAM-based classroom practices encourage both boys and girls to participate actively in learning.	3.25	0.54	Agree
19	I believe STEAM education promotes fairness in assessing students, regardless of gender.	3.80	0.45	Agree
20	STEAM integration helps increase girls' interest in science, technology, engineering, and mathematics subjects.	3.23	1.04	Agree
21	I perceive that STEAM education motivates boys and girls equally to pursue academic excellence.	2.80	0.59	Agree
22	STEAM projects and activities foster collaboration between male and female students without bias.	3.30	0.98	Agree
23	I believe that gender does not determine students' success when STEAM education is effectively applied.	3.01	0.84	Agree
	Cluster Mean	**3.27**		**Agree**

The result in Table 3 reveals that teachers perceive STEAM education as significantly contributing to gender equality in educational outcomes (SDG 5) in Anambra State's public and public-mission pre-tertiary schools. The mean scores ranged from 2.80 to 3.80, all indicating agreement. Teachers strongly perceived that STEAM education promotes fairness in assessing students regardless of gender (Mean = 3.80, SD = 0.45) and helps reduce gender stereotypes in subject choices (Mean = 3.64, SD = 0.82). They also agreed that STEAM-based practices encourage both boys and girls to participate actively (Mean = 3.25, SD = 0.54) and foster unbiased collaboration between male and female students (Mean = 3.30, SD = 0.98). While the lowest perception was observed on motivating boys and girls equally to pursue academic excellence (Mean = 2.80, SD = 0.59), the overall cluster means of 3.27 summarized that teachers to a great extent perceived that STEAM education predicted gender equality in educational outcomes (SDG 5) in public and public-mission pre-tertiary schools in Anambra State

Research Question One: What are teachers' perceptions of STEAM education effectiveness in reducing poverty (SDG 1) in public and public-mission pre-tertiary schools in Anambra State?

The findings revealed that teachers generally perceived STEAM education as effective in reducing poverty through skill acquisition, entrepreneurship development, employability enhancement, and practical problem-solving competencies. Teachers agreed that STEAM education equips learners with innovative and vocational skills capable of promoting self-reliance and sustainable livelihood opportunities. The cluster means of 2.96 indicated overall agreement among respondents that STEAM education contributes positively to poverty reduction and sustainable economic participation.

Research Question Two: How do teachers perceive STEAM education as influencing quality education (SDG 4) in public and public-mission pre-tertiary schools in Anambra State?

The findings showed that teachers perceived STEAM education as promoting quality education through experiential learning, creativity, collaboration, inquiry-based instruction, and critical thinking development. Teachers agreed that STEAM education improves learner engagement and supports practical application of knowledge.

Research Question Three: To what extent do teachers perceive STEAM education as promoting gender equality in educational outcomes (SDG 5) in public and public-mission pre-tertiary schools in Anambra State?

The findings indicated that teachers perceived STEAM education as capable of promoting inclusive participation and equal learning opportunities for male and female learners. Respondents

agreed that STEAM activities encourage collaboration and reduce gender stereotypes associated with science and technology education.

Discussion of Findings

The finding that teachers perceived STEAM education as effective in reducing poverty suggests that educators recognize practical learning as a pathway for self-reliance, employability, and sustainable livelihood development. This agrees with Hsiao and Su (2021), who found that STEAM learning significantly improves innovation and real-world problem-solving competencies among learners. It also corroborates Acosta Castellanos and Queiruga-Dios (2022), who reported that STEAM education contributes to economic sustainability through skill acquisition and entrepreneurial development. From an adult education perspective, this supports functional education as a driver of SDG 1 through empowerment and productive participation.

The finding on quality education indicates that teachers perceive STEAM education as promoting creativity, collaboration, experiential learning, and critical thinking competencies necessary for quality learning outcomes. This agrees with Herro et al. (2019), who found that STEAM implementation improves learner engagement and creativity when supported by teacher competence. Similarly, Perignat and Katz-Buonincontro (2019) reported that interdisciplinary STEAM practices significantly improve instructional quality and learner-centred engagement. This supports SDG 4 and aligns with adult education's emphasis on lifelong learning, professional development, and transformative learning.

The finding on gender equality implies that teachers perceive STEAM education as capable of promoting inclusive participation and reducing traditional gender stereotypes associated with science and technology learning. This agrees with Khine and Areepattamannil (2019), who observed that inclusive STEAM environments increase equal participation across gender groups. It also supports findings by Thibaut et al. (2018), which revealed that collaborative interdisciplinary instruction promotes educational equity and participation among diverse learners. This finding advances SDG 5 and reflects adult education principles of equity, inclusion, and social justice.

Collectively, these findings validate Constructivist Learning Theory and Andragogy Theory, both of which emphasize active engagement, experiential learning, practical relevance, and transformative participation as drivers of sustainable educational development.

Implications for Adult Education Practice

The findings imply that adult education institutions and policymakers must position STEAM education as a strategic driver for achieving SDGs 1, 4, and 5 through lifelong learning and professional development. The positive perception of STEAM for poverty reduction suggests that adult education programmes should integrate employability and entrepreneurial skill development as mechanisms for sustainable economic participation.

The finding on quality education implies that teacher retraining and continuous professional development should be strengthened to support innovative instructional practices that advance SDG 4 through learner-centred transformation.

The finding on gender equality indicates the need for inclusive adult learning frameworks that deliberately promote equal participation, digital access, and educational empowerment for both male and female learners in line with SDG 5

Adult education agencies should therefore establish sustainable community-based STEAM learning hubs that drive innovation, digital literacy, social inclusion, and sustainable development participation.

Conclusion

The study examined teachers' perceptions of STEAM education and Sustainable Development Goals from an adult education perspective in Anambra State. The findings revealed that teachers perceived STEAM education as effective in promoting poverty reduction, quality education, and gender equality through experiential learning, innovation, creativity, and problem-solving competencies.

The study concluded that STEAM education aligns strongly with the objectives of adult education because it promotes lifelong learning, empowerment, employability, social inclusion, and sustainable community development. Therefore, effective implementation of STEAM education requires continuous teacher professional development, improved educational infrastructure, and supportive educational policies.

Recommendations

Based strictly on the findings of this study, the following recommendations were made:

1. Since teachers perceived STEAM education as effective for poverty reduction, government and adult education agencies should integrate entrepreneurship-based STEAM activities into teacher development programmes to strengthen employability and sustainable livelihood skills in line with SDG 1.

2. Since teachers perceived STEAM education as improving quality education, school administrators should provide regular professional retraining for teachers on learner-centred and technology-driven instructional practices to enhance quality teaching and learning in line with SDG 4.

3. Since teachers perceived STEAM education as promoting gender equality, educational stakeholders should design inclusive STEAM participation frameworks that ensure equal access, engagement, and support for male and female learners in line with SDG 5.

4. Adult education policymakers should establish community-based STEAM lifelong learning centres where teachers and learners can continuously develop innovative competencies for sustainable social participation.

5. Public-private partnerships should support sustainable provision of digital tools and instructional facilities to strengthen effective STEAM implementation for long-term educational transformation.

References

Acosta Castellanos, P. M., & Queiruga-Dios, M. Á. (2022). From STEM to STEAM education and sustainable development goals: A systematic literature review. *Sustainability, 14*(19), 122 STEM. https://doi.org/10.3390/su1419122

Anekwe, J. U. (2021). Educational management and quality assurance in secondary schools in South-East Nigeria. *International Journal of Educational Administration and Policy Studies, 13*(2), 45–53.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied Developmental Science, 24*(2), 97-140. https://doi.org/10.1080/10888691.2018.1537791

Freire, P. (1970). *Pedagogy of the oppressed*. Continuum.

Herro, D., Quigley, C., Andrews, J., & Delacruz, G. (2019). Co-measuring creativity in STEAM activities. *The STEAM Journal, 4*(2), 1–13.

Hsiao, P. W., & Su, C. H. (2021). A study on the impact of STEAM education for sustainable development courses and its effects on student motivation and learning. *Sustainability, 13*(7), 3772. https://doi.org/10.3390/su13073772

Khine, M. S., & Areepattamannil, S. (2019). *STEAM education: Theory and practice.* Springer.

Knowles, M. S. (1980). *The modern practice of adult education: From pedagogy to andragogy*. Cambridge Books.

Knowles, M. S., Holton, E. F., & Swanson, R. A. (2020). *The adult learner* (9th ed.). Routledge.

Leal Filho, W., Azul, A. M., Brandli, L., Özuyar, P. G., & Wall, T. (2019). *Quality education for sustainable development goals*. Encyclopedia of the UN Sustainable Development Goals. Springer.

OECD. (2021). The future of education and skills: Education 2030. OECD Publishing.

Perignat, E., & Katz-Buonincontro, J. (2019). STEAM in practice and research: An integrative literature review. *Thinking Skills and Creativity, 31,* 31–43. https://doi.org/10.1016/j.tsc.2018.10.002

Piaget, J. (1972). *The psychology of the child*. Basic Books.

Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., & Depaepe, F. (2018). Integrated STEM education: A systematic review of instructional practices in secondary education. *European Journal of STEM Education, 3*(1), 1–12. https://doi.org/10.20897/ejsteme/85525

UNESCO. (2021). *Reimagining our futures together: A new social contract for education*. UNESCO Publishing.

World Bank. (2018). *World development report 2018: Learning to realize education's promise*. World Bank.

.