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A Study on 3D Printer in Japanese Schools: Focus on Courses of Study and Number of Articles

Shoko Usui [*], Michiyo Oda [†],
Yoko Noborimoto [‡], Hidemitsu Furukawa [*]

Abstract

The use of 3D printers in education is becoming increasingly common. However, there is a paucity of objective data regarding their implementation in Japanese schools. Furthermore, few resources in languages other than Japanese present this information, creating barriers to international comparative research. To bridge this knowledge gap, this paper provides empirical data on the integration of 3D printers into Japanese school education. Our analysis focuses on two key areas: (1) how 3D printers are addressed in the Commentary on the Courses of Study (a significant shift from their absence in the prior edition to inclusion in four current subject areas), and (2) the publication trends of 3D printer-related articles in Japanese academic literature. Our findings indicate that while such articles began appearing around 2014, their volume has remained modest with only a slight increase over time.

Keywords: 3D printing, Commentary on the Courses of Study, Japanese School Education.

1 Introduction

3D printers are considered a relatively new molding technology that was developed in the 1970s and commercialized in the 1980s. The patent for the Fused Deposition Modeling (FDM) method, which is currently the most widely used 3D printing method, was obtained by Stratasys in the late 1980s. The basic patent's term of protection expired in 2009, after which research and development in the field rapidly advanced. The year 2013, when then U.S. President Barack Obama emphasized the effectiveness of 3D printers in his State of the Union address, is often referred to as the "first year of 3D printing." 3D printers are also expected to play a significant role in school education. John Couch, former head of Apple's education division, stated that "3D printers have the potential to fundamentally change the way children learn [1]." In recent years, affordable models have enabled the introduction of 3D printers in educational settings.

In Japan, the 2014 New Monozukuri Report by the Ministry of Economy, Trade and Industry stated, "It is necessary to introduce simple 3D CAD and 3D printers in elementary education and expose students to 3D manufacturing from an early stage to foster creativity in three dimensions." This statement has driven calls for enhancing school education with 3D printers. Furthermore, in 2019, 3D printers were added to the guidelines for the development of teaching materials for junior high schools [2].

[*] Department of Mechanical Systems Engineering, Yamagata University, Yonezawa, Japan
[†] Faculty of Foreign Studies, Reitaku University, Kashiwa, Japan
[‡] Graduate School of Education, Tokyo Gakugei University, Tokyo, Japan

Literature on the use of 3D printers in school education in other countries is widely available in English, thereby ensuring accessibility for the international research community. By comparison, there is a paucity of objective data concerning the current state of 3D printer utilization in Japanese schools, and a lack of resources that present such information in languages other than Japanese. This scarcity poses a barrier to international understanding and comparative research. Therefore, this paper aims to provide objective data on the current state of 3D printer use in Japanese schools for researchers and practitioners both within Japan and abroad. It examines (1) the treatment of 3D printers in the Japanese Commentary on the Courses of Study and (2) trends in the number of publications on 3D printer use in Japanese schools. We believe this study will serve as a valuable reference for understanding the current state of 3D printer integration in Japanese school education.

2 3D Printers in Japanese Commentary on the Courses of Study

2.1 Objective and Methods

This section aims to clarify how 3D printers are addressed in the Japanese Commentary on the Courses of Study.

In Japan, there are 13 subject areas in elementary school, 12 in junior high school, and 19 in senior high school (Table 1). In Japanese senior high schools, in addition to the general academic track, there are specialized academic tracks. Including all of these, there are 19 subject areas in total. The content of each subject area is specified in the Commentary on the Courses of Study, which is revised approximately every 10 years. Schools have implemented the current Courses of Study starting in the designated year for each educational level: Year 2020 for elementary schools, Year 2021 for junior high schools, and Year 2022 for senior high schools. The Commentary serves as a supplementary resource that explains the Courses of Study in an accessible manner, providing detailed guidelines for teachers.

In this section, we examined the occurrence of the term "3D printer" in two editions of the Commentary on the Courses of Study: the 2008–2009 editions (hereinafter previous Courses of Study) and the 2017–2018 editions (hereinafter current Courses of Study). The analysis covered all subjects across three educational levels: 13 in elementary school, 12 in junior high school, and 19 in senior high school.

Since 3D printing is a relatively new technology, the related terms "CAD" and "digital fabrication" were also included in the analysis to ensure comprehensiveness. 3D printers typically rely on modeling software to generate digital data for printing objects. However, in educational contexts, the term "CAD" is often used regardless of whether the objects are 2D or 3D. Additionally, "digital fabrication" is a broader term encompassing various manufacturing technologies based on digital data, including 3D printers and laser cutters. This term has gained traction in recent years, particularly in discussions on manufacturing education involving 3D printing. The extracted terms were categorized by school level and subject for analysis.

2.2 Results

Table 2 presents the subjects in which each term was found, along with their frequency of occurrence. In the previous Courses of Study, neither "3D printer" nor "digital fabrication" appeared in any subjects. However, "CAD" was mentioned in Home Economics, Agriculture, Industry, and Fisheries at the senior high school.

Table 1: Subject Area of Japanese School

Elementary school	Junior high school	Senior High school	
Japanese Language	Japanese Language	Japanese Language	
Social Studies	Social Studies	Geography and History	
		Civics	
Arithmetic	Mathematics	Mathematics	
Science	Science	Science	
Life Environmental Studies			
Music	Music	Art	
Arts and Crafts	Art		
Home Economics	Technology and Home Economics	Home Economics	
Physical Education	Health and Physical Education	Health and Physical Education	
Foreign Language (Activities)	Foreign Languages	Foreign Languages	
Special Subject: Moral Education	Special Subject: Moral Education		
Period for Integrated Studies	Period for Integrated Studies	Period for Inquiry-Based Cross-Disciplinary Study	
Special Activities	Special Activities	Special Activities	
		Information	Business
		Science and Mathematics	Fisheries
※Shaded area: "3D printer(s)" are mentioned in the current Courses of Study		Agriculture	Nursing
		Industry	Welfare

Table 2: Subject Area Each Term Was Mentioned

School Type	Subject Area	Term (times)
Previous Courses of Study (The 2008–2009 editions)		
Elementary school	No mention of "3D printer," "CAD," or "Digital fabrication" in any subject.	
Junior high school	No mention of "3D printer," "CAD," or "Digital fabrication" in any subject.	
Senior High school	Home Economics	・CAD(8)
	Agriculture	・CAD(2)
	Industry	・CAD(25)
	Fisheries	・CAD(3)
Current Courses of Study (The 2017–2018 editions)		
Elementary school	No mention of "3D printer," "CAD," or "Digital fabrication" in any subject.	
Junior high school	Technology and Home Economics	・CAD(2) ・**3D Printer(1)**
Senior High school	Art	・**3D Printer(2)** ・Digital fabrication(1)
	Home Economics	・CAD(9)
	Information	・**3D Printer(1)**
	Agriculture	・CAD(1)
	Industry	・CAD(13) ・**3D Printer(1)**
	Fisheries	・CAD(4)

In the current Courses of Study, "3D printer" appears for the first time in four subjects: (1) Technology and Home Economics in junior high schools, (2) Art, (3) Information, and (4) Industry in senior high schools. The term "digital fabrication" was newly introduced in (2) Art, while "CAD" was newly incorporated into junior high school Technology and Home Economics.

Table 3 outlines the sentences in which the term 3D printer appears in the current Courses of Study, categorized by school type and subject. Since MEXT has not published an official English translation, the authors translated the contents of Table 3 into English.

1) Junior High School: Technology and Home Economics

In the unit "wood and processing technology" of Technology and Home Economics, "CAD" appears twice and "3D printer" once. The text specifies that students should use 3D CAD and 3D printers to develop solutions to problems and gain hands-on experience with 3D printing technology.

2) Senior High School: Art

In the subject area of Art, "Craft Design," which is part of the specialized academic tracks, "3D printer" appears twice, while "digital fabrication" appears once. The text emphasizes that computer-generated designs should not remain as conceptual plans but should be physically realized using 3D printers. Additionally, digital fabrication is mentioned in the context of designing with consideration for productivity and mass production.

3) Senior High School: Information

In the new subject area "Information I" (introduced in 2022), none of the analyzed terms appear. However, in the subject area of "Information" within the specialized academic tracks, "3D printer" appears once. Specifically, In the unit "Expression and Manage of Information," it encourages students to develop an interest in emerging technologies and methods of information representation through exposure to 3D printing. However, it does not indicate that students are expected to operate 3D printers themselves.

Table 3: Mentions of 3D Printers in the Commentary on the Courses of Study

Subject Area		Excerpt from sentences where the term 3D printer is mentioned ＊English translation by authors
Junior high school	Technology and Home Economics	When designing solutions to problems, students should be guided to organize their thoughts and use design drawings appropriately to clarify potential issues before handling actual materials or processing components. This approach also aims to foster better ideas. Furthermore, when materializing solutions, it may be considered to have students create prototypes using 3D CAD and **3D printers**.
Senior High school	Art	In graphical representation and drafting, it is necessary to ensure that these skills are not limited to mere planning but are integrated with the manufacturing process for practical application. For example, in computer-aided drafting, students may use the created data to produce actual models with a **3D printer** or similar tools.
		In product design, students should understand material properties, manufacturing technologies, and production processes. Depending on the school's environment, they should also be encouraged to consider functional designs that take productivity and mass production into account, such as utilizing casting molds, **3D printers**, and laser cutters in digital fabrication.
	Information	Students should explore representations of digital information that are deeply connected to the physical world and objects. This includes topics such as virtual reality (VR), augmented reality (AR), and mixed reality (MR), as well as content that responds to human or object movements and manufacturing using **3D printers**.
	Industry	As topics related to advanced technologies, possible practical exercises include training on machine tools such as laser processing machines, measurement exercises using three-dimensional measuring instruments, exercises on fuel cells, optical communication, satellite communication, and **3D printers**, among others.

4) Senior High School: Industry

In the subject area of Industry, which is part of the specialized academic tracks, "CAD" appears 13 times, while "3D printer" appears once. In the unit "Practice," 3D printers are described as advanced technology, and students are expected to gain hands-on experience using 3D printers.

2.3 Discussion

Among the four subject areas where "3D printer" appears, Art, Information, and Industry are part of the specialized academic tracks and are not compulsory subjects. Thus, the only mandatory subject area where students engage with 3D printers is junior high school Technology and Home Economics.

In Technology and Home Economics, Art, and Industry, students are expected to use 3D printers to create prototypes and engage in hands-on learning. In contrast, in Information, students are only expected to develop an interest in 3D printers without actually operating them. This distinction reflects differing educational approaches to 3D printing across subject areas.

3 3D Printers Articles in Japanese School Education

3.1 Objective and Methods

This section aims to determine the number of articles on 3D printers in Japanese school education, written in Japanese, categorized by year of publication, and to analyze their trends over time.

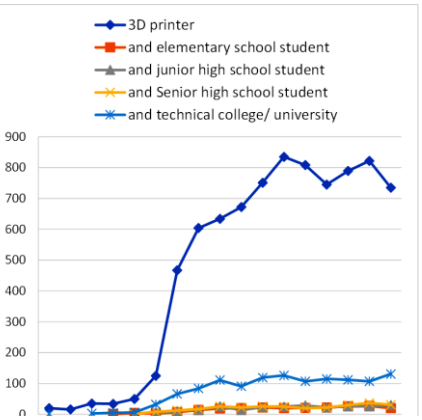
J-STAGE, an electronic journal platform operated by the Japan Science and Technology Agency (JST), was used as the primary source for collecting articles. This platform is the largest repository of peer-reviewed articles in Japan and covers the majority of academic publications written in Japanese.

For this section, the keyword "3D printer" was entered into the search engine, along with additional filters: "AND elementary school students," "AND junior high school students," "AND senior high school students," and "AND technical college/university students." The retrieved articles were categorized by year of publication, and their distribution over time was analyzed. Additionally, both peer-reviewed and non-peer-reviewed articles were included in the analysis, as non-refereed articles may also contain valuable research findings.

Table 4: Annual Number of J-STAGE Articles Containing Search Terms

*Figures from 2008 onwards are additionally illustrated using line graphs.

Year	3D printer	Year	3D printer	and elementary school student	and junior high school student	and Senior high school student	and technical college/ university
1990	1	2008	20				1
1994	2	2009	16				
1995		2010	35				3
1996	2	2011	34	1	2		5
1997	2	2012	50	4		2	6
1998	3	2013	125	2	3	8	32
1999		2014	467	7	10	13	66
2000		2015	604	14	14	17	84
2001	2	2016	634	19	26	26	111
2002	2	2017	672	20	14	22	91
2003	2	2018	751	22	23	26	119
2004		2019	835	20	25	25	126
2005	9	2020	808	21	29	20	107
2006	4	2021	745	22	22	22	115
2007	12	2022	789	26	26	30	112
		2023	822	27	26	37	107



3.2 Results

As of January 31, 2025, a total of 8,183 articles were identified containing '3D printer,' including 225 related to elementary school students, 250 to junior high school students, 279 to senior high school students, and 1,216 to technical college/university students. Among the 8,183 articles on "3D printers," 4,337 were journal articles, 3,231 were conference proceedings/abstracts, 189 were research/technical reports, and 426 were commentaries/general information pieces.

Table 4 presents the number of articles by year of publication. The data indicate that the number of articles containing "3D printer" remained between 0 and a few per year from the 1990s to 2004. However, from 2008 onward, the number of publications gradually increased, with a sharp rise from 2014. As noted in the introduction, 2013 is often considered the inaugural year of 3D printing technology. This trend suggests that awareness and research on 3D printers in Japan expanded following this period.

In contrast, articles specifically mentioning "AND elementary school students," "AND junior high school students," and "AND senior high school students" began appearing around 2010, saw an increase around 2014, and then stabilized at around 20–30 articles per year after 2022. The number of articles related to higher education, particularly for technical college and university students, was significantly greater than those focusing on primary and secondary education. However, the numbers should be interpreted with caution due to potential delays in article indexing within the platform.

3.3 Discussion

The overall number of articles on 3D printers remains limited, indicating that their integration into Japanese school education is still modest. Therefore, in addition to accumulating case studies of 3D printer utilization within the four existing subject areas, it is crucial to explore the potential of 3D printers in areas such as cross-curricular learning and integrated inquiry-based education.

4 General Discussion and Conclusion

This study investigated the integration of 3D printers in Japanese school education by analyzing national curriculum documents and publication trends. Since around 2014, research on the educational use of 3D printing has gradually emerged. The current Courses of Study Commentary, implemented from 2020 onward, includes references to 3D printers in four subject areas, indicating a growing institutional presence. This suggests that research and practice developed independently before policy integration.

Following this, the DX High School initiative—introduced in Japan in 2024 [3]—provides subsidies for equipment such as 3D printers and is likely accelerating the adoption of digital fabrication tools in schools. Although our previous research has identified challenges such as the complexity of 3D modeling and long printing times, practical workshops with high school students have shown that 3D printing can enhance student agency and support new forms of creative expression [4]. In Japan, as national policy increasingly emphasizes cross-curricular and inquiry-based learning through STEAM education [5], 3D printing has the potential to serve not only as a digital learning tool but also as a means of fostering creativity, problem-solving, and learner autonomy. Future efforts in 3D printer-based learning should focus on developing instructional models, teacher training, verification of educational effectiveness, and stronger connections between practical research and curriculum development.

Author's Note

This paper is a full-length reorganization of the contents [6] [7] presented by the authors in Japanese, and incorporates new findings not presented in the earlier Japanese versions.

References

[1] J. Couch and J. Towne, “3D PRINTING, Chapter 14, Rewiring Education: How Technology Can Unlock Every Student’s Potential,” BenBella Books, 2018, pp. 198–199.

[2] Ministry of Education, Culture, Sports, Science and Technology, https://www.mext.go.jp/component/a_menu/education/detail/__icsFiles/afieldfile/2019/08/06/1316723_4_2.pdf.

[3] Ministry of Education, Culture, Sports, Science and Technology, https://www.mext.go.jp/content/20241129_mxt_koukou01_000036932_0001.pdf.

[4] S. Usui, Y. Noborimoto, Y. Sakurai, Y. Watanabe, H. Furukawa, “An Examination of Learning to Create 3-D Works Using GelPiPer in Japanese School Education,” Conference on 4D and Functional Fabrication, 2021, pp. 67-70.

[5] Ministry of Education, Culture, Sports, Science and Technology, https://www.mext.go.jp/content/20210126-mxt_syoto02-000012321_2-4.pdf.

[6] S. Usui, Y. Noborimoto, Y. Watanabe, and H. Furukawa, “Examination of Trends in Research on the School Educational Use of 3D Printers and Research Cases in Elementary Schools in

Japan," Proceedings of the CIEC Spring Conference, 2021, pp. 80–85.

[7] S. Usui, Y. Noborimoto, "An Examination of the Content Regarding 3D Printers in the Japanese Commentary to the Curriculum Guidelines," Research report of JSET Conferences JSET22-1, 2022, pp. 143-146.