Strategies for Implementing Maker Literacy Education in University Libraries: Postprint

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Date: 2023-08-27T00:00:00+00:00

Abstract

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Full Text

Preamble

Research on Strategies for Implementing Maker Literacy Education in University Libraries

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ChinaXiv Cooperative Journal, Vol. 62, No. 19, October 2018

Abstract

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Keywords: University Library; Maker Literacy Education; Maker Space
Classification Number: G250
DOI: 10.13266/j.issn.0252-3116.2018.19.003

Introduction

The vigorous development of new technologies such as computer and internet technology has, on the one hand, dramatically reduced the cost of information and knowledge storage and dissemination, making active selection ability an increasingly important factor in efficient learning. On the other hand, these technologies have jointly created a new platform where traditional information asymmetry phenomena are gradually weakening, and resource allocation systems maintained by geography and personal networks are rapidly disintegrating. In this new environment, only continuous innovation ensures survival and development. Against this backdrop, maker spaces have rapidly emerged, and with the continuous development of the maker movement, maker literacy—emphasizing innovative and creative capabilities—has arisen. How to effectively improve maker literacy has become a key concern for university students, while society urgently needs more talent possessing such literacy.

Universities bear significant responsibility for enhancing students' maker literacy. As academic exchange centers, university libraries also shoulder the task of talent cultivation. On one hand, traditional services centered on literature storage have undergone tremendous changes under new circumstances, with growing demand for libraries to transform into knowledge centers, learning centers, and exchange centers. On the other hand, university libraries' unique advantages—including spatial resources, rich information resources, and interdisciplinary exchange platforms—make them important venues for implementing maker literacy education. The introduction of maker spaces holds great significance for

university libraries, as their functions align well with those of the library.

In the field of university library maker spaces and maker literacy education, foreign scholars have produced rich research achievements with considerable theoretical depth. Scholars such as I. Fourne, starting from the core functions of maker spaces and libraries, argue that when combined, they become collaborative and learning spaces associated with information exploration and knowledge expansion, effectively stimulating and applying creative ideas, and serving as shared spaces for creating and disseminating new knowledge, experiences, and entrepreneurial spirit. T. Colegrove analyzed the distinctions between near-synonyms such as collaborative spaces, maker spaces, and fabrication laboratories, pointing out the distinct advantages of establishing maker spaces in libraries. S. Diane et al., through investigating maker spaces in Australian public libraries, concluded that maker spaces help libraries achieve conceptual renewal and functional transformation, becoming entities with deepened functions and spirit.

In contrast, domestic research remains in its infancy. Zheng Yanlin detailed implementation models of maker education in American universities from consciousness, planning, and practice perspectives, offering suggestions for Chinese universities. Wang Youmei and Chen Zan'an summarized four typical models of American university maker spaces and analyzed how to cultivate users' maker literacy based on these spaces. Liu Xueni pointed out the inevitability of maker spaces appearing in libraries and that their construction should focus on user needs, but without elaborating on those needs. Sun Jianhui and Dai Wenjing comprehensively surveyed university library users' demands for maker spaces, but focused mainly on the spaces themselves rather than maker activities and the broader context of university-wide maker literacy education. Overall, domestic research in this field concentrates on introducing foreign advanced experiences and defining relevant concepts, lacking more detailed analysis of users' current maker literacy status, their needs for various maker activities, and the contextual background for university libraries implementing maker literacy education.

1. Maker Literacy and Maker Literacy Education

1.1 Makers and Maker Spaces

The Chinese term "创客" (maker) originates from the English words "Maker" or "Hacker," referring to individuals who, not for profit, strive to transform creative ideas into reality. Makers' main characteristics include persistent innovation, continuous practice, willingness to share, and pursuit of excellence. Regarding the definition of maker spaces, Chinese library scholars have cited *Make* magazine's description: a physical place that functions as an open communication laboratory, studio, or machine shop with processing workshop capabilities.

1.2 The Connotation of Maker Literacy

Maker literacy is a relatively new concept. Several scholars have offered relevant formulations in their research, as summarized in . The table reveals that maker literacy determines whether learners can adapt to society and work, referring to the ability to creatively employ various technical and non-technical means, discover and deconstruct problems through teamwork, find solutions, and form creative artifacts through continuous experimentation. This encompasses interpersonal communication, teamwork, innovative problem-solving, critical thinking, and professional skills. Other perspectives include maker literacy comprising innovative thinking, hands-on ability, participation and sharing awareness, and engineering thinking. Some emphasize that maker literacy should include innovation awareness, thinking, and practical ability, while others propose five dimensions: maker consciousness, ethics, capability, technology, and spirit.

Based on existing research and the meaning of maker spaces, the author argues that maker literacy's connotation should consist of several components, as shown in [Figure 1: see original paper].

1.2.1 Long-term Stable Interest in Innovation The emergence and development of maker spaces are entirely driven by people who love creation. A long-term, stable interest in innovation and creation is a universal characteristic of makers and the most fundamental component of maker literacy. This interest includes: (1) Continuously exploring and adhering to one's areas of interest while maintaining an attitude of acknowledging deficiencies; for makers, innovation is an active behavior motivated by interest. (2) Confidence in problem-solving; believing that problems can be solved through various channels is crucial for transforming interest into action. Makers often work in fields they are interested in but not necessarily proficient in, and the knowledge and experience required in various creation processes are often interdisciplinary. Without confidence as support, maker activities would become mere daydreams.

1.2.2 Ability to Discover and Describe Problems After developing an interest in innovation, the ability to discover and describe problems in practice is key to maker literacy. Problem-discovery ability includes critical thinking and analytical classification skills. Problem-description ability involves understanding causes, efficiently describing and recording problems, and considering them from different perspectives. These abilities are essential for modern university students, helping to compensate for the current mainstream exam-oriented education's emphasis on problem-solving while neglecting problem-finding, and better preparing students for future workplace demands.

1.2.3 Comprehensive Practical Ability Comprehensive practical ability refers to the capacity to innovatively plan and implement solutions after fully recognizing and comprehensively describing problems. It is the core of maker literacy and mainly includes: (1) Information gathering and organization; in at-

tempting to solve problems, comprehensively and continuously understanding existing solutions provides the foundation for innovation. In the new era, retrieving, screening, collecting, and organizing explicit and tacit knowledge through the internet, print media, and relevant individuals presents constant challenges. (2) Innovative thinking; based on comprehensive understanding of problems, using logical and non-logical thinking to break through previous or fixed problem-solving patterns and generate new ideas. Innovative thinking exists throughout the entire maker activity process, including intuitive thinking, logical reasoning, and divergent thinking. (3) Communication and collaboration; for makers, this ability runs through all processes and includes rational division of labor, task planning, teamwork spirit, and an inclusive, open mindset. (4) Hands-on operation; although creating physical objects is no longer the only activity in maker spaces, understanding and applying various software and hardware tools remains crucial. This includes both actively learning to master required tools and using them to design or manufacture new knowledge products. (5) Writing ability and intellectual property awareness; writing and summarizing are necessary for recording results, sharing with others, and providing references for future activities. As platforms for equal knowledge creation, maker spaces require high IP awareness to protect creators and maintain a healthy atmosphere, with good writing skills supporting this protection.

2. Background of University Libraries Carrying Out Maker Literacy Education

This survey targeted Fudan University faculty and students, covering: (1) basic user information including disciplinary background and education level; (2) current maker literacy status across multiple dimensions; (3) external environment for maker literacy education; and (4) user needs and attitudes toward relevant maker activities and services.

The electronic questionnaire was distributed through the Fudan University Library WeChat official account, restricted to university faculty and students, for one month. A total of 1,156 responses were collected, with 1,093 valid responses. Among valid responses, 1,070 were from students and 23 from faculty and others. Within the student group, 692 were undergraduates (64.67%), 287 were master's students (26.82%), and 91 were doctoral students (8.5%).

2.1 Overall Assessment of Users' Maker Literacy

After briefly introducing the components of maker literacy, the survey assessed users' self-evaluation of their maker literacy, with results shown in . The data reveals that most respondents were dissatisfied with their current maker literacy status.

TABLE:2 User Self-Assessment of Maker Literacy
A. Excellent, can demonstrate these abilities well in study and research: 19.76%
B. Average, lacking in some abilities: 61.48%

C. Poor, lacking in most listed abilities: 16.56%
D. Very poor, urgently need improvement in all abilities: 2.20%

2.2 Attitudes and Experiences Toward Innovation

The survey evaluated users' interest and attitudes toward innovation. In recent years, the state has vigorously encouraged "three creations" (innovation, creativity, entrepreneurship), but faculty and students' tangible experiences remain unclear. Regarding this question, 40.16% of respondents not only highly endorsed innovation but actively sought opportunities to engage in the innovation process. However, 52.88% endorsed the concept but reported "not many tangible experiences." Higher education levels correlated with stronger identification with innovation.

2.3 Attitudes and Capabilities Regarding Collaboration

The survey assessed communication and collaboration abilities. Results are shown in .

TABLE:3 User Assessment of Collaboration Attitudes and Capabilities
A. Collaboration is important, and I can efficiently conduct deep collaboration: 48.95%
B. Collaboration is important, but I feel it often encounters various problems; simple task assignment works better: 43.73%
C. Collaboration is not very important, but I can efficiently complete work in collaboration: 3.93%
D. Collaboration is not very important; I prefer working independently: 3.39%

2.4 Factors Hindering Maker Activities

Understanding which factors hinder maker activities reflects users' hands-on operation and innovative thinking abilities, while also indicating hardware needs for maker literacy education. Survey results are shown in .

TABLE:4 Factors Hindering Maker Activities
A. Lack understanding of mechanics, manufacturing, design, and cannot apply them: 74.29%
B. Lack creativity and inspiration, don't know what to make: 67.15%
C. Lack interest, feel it's not closely related to employment: 33.85%
D. No convenient tools for making: 47.03%

2.5 Preferences for Maker Space Tools

Demand for various maker space tools reflects specific user needs. Typical maker space tools can be divided into four categories: (1) conventional medium-to-large physical fabrication tools like 3D printers, 3D scanners, cutters, grinders; (2) computer software like SketchUp, video editing software, Photoshop; (3) open-source hardware like Arduino, BeagleBone; and (4) hand tools like ropes, fabric,

paper, scissors. While many maker spaces emphasize physical tools, this survey found that university library users actually value creative software more highly.

The survey listed four tool types and asked respondents to rank them by importance. Scoring assigned 4 points for most important, 3 for second, down to 1 for least important. Results, showing minimal variation across user types, are presented in .

TABLE:5 User Preferences for Maker Space Tools
A. New technology fabrication tools (3D printers, scanners, cutters, knitting machines): [score]
B. Professional software (programming, video editing, 3D modeling, audio production): [score]
C. Hand materials and tools (ropes, fabric, paper, scissors): [score]
D. Open-source hardware (Arduino, etc.): [score]

2.6 Experience of Overall Innovation Atmosphere

A key task of maker literacy education is building a strong maker culture that creates a virtuous cycle between educators and learners. Understanding the existing innovation atmosphere facilitates effective education. When asked whether university courses and activities emphasize active creation and innovation, most respondents felt there was some atmosphere but no special emphasis, as shown in . Although society strongly encourages innovation, most faculty and students lack tangible experiences, with nearly 17% expressing disappointment in the innovation atmosphere.

TABLE:6 User Experience of University Innovation Atmosphere
A. Very strong emphasis, widespread encouragement of innovation: 18.57%
B. Average, some atmosphere but no special feeling: 64.96%
C. Poor, most courses emphasize one-way teaching: 14.64%
D. Very poor, no real innovation: 1.83%

2.7 Preferences for Maker Space Activities

University maker spaces are the best platforms for maker literacy education. While existing research emphasizes the value of entrepreneurship and creative transformation as primary goals, survey results show university library users are not particularly interested in creative value transformation. Using the same ranking method, scores for four activity types are shown in .

TABLE:7 User Preferences for Maker Space Activities
(Activities ranked by importance: creative inspiration lectures, creation process guidance, enthusiast exchange platforms, innovation competitions emphasizing value transformation)

Users valued exchange and sharing functions most, followed by creation-related activities. Notably, 28.73% and 32.2% of respondents ranked creative inspiration and latest research results as most and second-most important, respectively,

far exceeding guidance on creation processes. Value transformation activities received the lowest score, with 54.53% ranking them least important.

2.8 Preferences for Training Methods

New tools and technologies in maker spaces require corresponding training. Three main training models exist: (1) Face-to-face courses in formal classroom settings, often as university electives, offering systematic but potentially less personalized instruction; (2) Specialized training for specific maker groups upon request, providing highly targeted and practical guidance but potentially limiting creative thinking; (3) Online training where users complete courses and exams to gain tool usage rights, balancing efficiency and resource conservation but lacking hands-on practice.

User preferences were not particularly pronounced: 48.67% preferred specialized training, 25.89% favored face-to-face courses, and 25.43% preferred online training. Undergraduate preferences varied by grade level, with lower-year students preferring face-to-face courses more than upper-year students, while graduate students showed no significant differences.

3. Strategies for University Libraries to Carry Out Maker Literacy Education

University libraries possess distinct advantages for implementing maker literacy education:

First, they have complete disciplinary systems and professional talent. Maker spaces serve as bases for maker literacy education, and instructors providing guidance are crucial. As university research and information exchange centers, libraries are supported by comprehensive disciplinary systems, enabling more professional and efficient guidance services in specific creative activities like new tool operation and product design.

Second, libraries possess abundant resources and new technologies. Modern libraries have ample space resources that can be repurposed for maker spaces. As important institutions supporting teaching and research, they provide physical space, collections, and professional talent through subject librarian systems that track latest scientific and technological developments. Additionally, information literacy education experience provides a foundation for maker literacy education.

Third, lower operating costs. While most social maker spaces face substantial costs for property, maintenance, operations, and personnel, requiring stable profits and limiting accessibility, university library maker spaces, supported by libraries and universities, can bear various costs and are more conducive to universal maker literacy education.

3.1 Actively Construct Maker Space Hardware Environments Meeting User Needs

Maker spaces are venues for student creation and essential infrastructure for maker literacy education. There is no uniform template; construction should be arranged according to actual conditions. User interest in professional software even exceeds physical fabrication tools, indicating that producing physical objects is not the core activity. Emerging open-source hardware has not received significant attention, while hand tools, emphasized in some maker spaces, were rated least important.

This suggests that software configuration should take priority over advanced tools, especially for libraries with limited budgets. Software is relatively easier to configure than expensive fabrication tools. Libraries should prioritize widely-used software in design, graphics, and video production, with later adjustments based on user feedback. Software can be provided through various means: publishing on online platforms for paid or free download, or installing on public computers if space permits.

Of course, emphasizing software does not mean ignoring other hardware. Besides computers and software, common communication tools like whiteboards and projectors should be considered, and emerging fabrication tools should be introduced when conditions allow.

3.2 Establish Diverse and Flexible Foundational Maker Curricula

Maker literacy education centers on project-based creative activities rather than traditional courses. However, guidance on widely-used new technologies, universally-needed knowledge, and maker space usage can be provided through foundational courses.

University libraries should adopt team-based specialized training as primary, supplemented by online training and electives. Specialized training should be mainly appointment-based with proactive training as supplement, focusing on specific tool operations. Online training aims to promote maker spaces and introduce new tools. Electives can be flexibly organized by embedding them in relevant college courses, with libraries providing tools for demonstration, or by developing professional teaching teams to offer independent courses. Instructors need not be limited to university faculty but can include technicians or outstanding students.

Curriculum content can be arranged in three aspects: (1) Popularization courses introducing maker spaces, tools, and typical cases to help users understand functions and basic technologies; (2) General maker courses covering traditional information literacy, writing training, and other universally needed abilities; (3) Targeted courses for advanced users, covering aesthetics in design, techniques in fabrication, and latest machines and principles.

3.3 Build a Guidance-Oriented Service System

The survey reveals three key issues: (1) Faculty and students' information gathering and innovative thinking abilities are not ideal; (2) Hands-on operation ability is most lacking; (3) Collaboration ability is valued but at average level. Therefore, building a guidance-oriented service system is crucial.

Service teams should include not only course instructors but also disciplinary guides, daily managers, and activity organizers—roles that may overlap. All service personnel should adopt a maker-centered philosophy, exploring user needs, guiding interest discovery, and encouraging innovative ideas. Given the interdisciplinary nature of maker education, disciplinary service personnel help users understand different knowledge domains. A team mentorship system can be established for stable teams, with designated staff providing guidance on project completion and technical tools.

Service personnel should emphasize hands-on guidance, combining theory with practice through case explanations and live demonstrations. They should guide efficient collaboration by arranging interdisciplinary projects and providing division-of-labor suggestions for stable teams. Writing ability cultivation should be encouraged to help students organize ideas, record creativity, and develop project plans. To stimulate creativity, libraries should: (1) Improve traditional information literacy education to help users find interest areas and reference others' achievements; (2) Introduce new achievements, including technologies, tools, cases, and products; (3) Popularize common creativity methods like brainstorming, interdisciplinary exchange, and divergent thinking.

3.4 Focus on Popularization Activities and Encourage Student Self-Organization

The current university innovation atmosphere is insufficient, and various activities in maker spaces effectively promote maker literacy education. Activities can include internal maker space events, cooperation with enterprises, and joint activities with other schools or colleges. These not only mobilize participating students but also help form a university maker culture—a crucial factor for sustainable education promotion.

University faculty and students highly value innovation but lack tangible experiences, likely due to insufficient opportunities for open innovation practice. Therefore, focusing on popularization activities encouraging participation is important. These should emphasize experiential functions, such as regular introductions to specific technologies combined with trendy applications. For example, offering introductory Photoshop workshops for portrait photography or WeChat mini-program series can satisfy curiosity while providing creation opportunities.

Since students show strong tendencies toward self-organization, libraries should focus on promoting maker space functions and actively inviting potential core

members. By working with colleges or faculty to identify capable or creative students, libraries can invite them to experience maker spaces or develop projects. Students making outstanding contributions can be invited as regular volunteers or to form maker space operation committees, organizing activities more flexibly within regulatory frameworks.

3.5 Provide Project Opportunities Without Emphasizing Value Transformation

Although users currently show limited demand for creative value transformation, maker spaces should actively provide project opportunities. Besides self-organized group projects, maker spaces can regularly offer "reference project lists" proposed by cooperating colleges or the library itself. These can provide either specific project documentation for application or general ideas for all participants to try. Key projects can cooperate with colleges as graduation designs or research topics, enhancing student enthusiasm while improving maker space service systems.

Maker spaces should not emphasize inevitable connections between maker activities and entrepreneurship but can provide corresponding opportunities. For exceptional projects, libraries can assess and attempt cooperation with enterprises, encouraging commercialization and providing new employment pathways for students.

Conclusion

University library users' maker literacy remains at a relatively low level overall. University libraries should leverage their advantages and actively implement maker literacy education to meet the functional transformation trends of the new era. However, this study has limitations: the survey was limited to Fudan University and may not represent all university library users; the research focused on early-stage strategies, with less discussion on mature development stages; and theoretical analysis requires further deepening.

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Author Contributions

Wang Moyan: Conceived the research idea, designed the questionnaire, organized data, and wrote the paper.
Ying Jun: Refined the research idea, distributed the questionnaire, and revised the paper.

Research on the Strategies of Carrying Out the Maker Literacy Education in University Library

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Abstract: [Purpose/significance] Actively carrying out all kinds of maker activities to improve students' maker literacy meets the requirements of the new era for the cultivation of university students. This paper puts forward the specific strategies of carrying out the maker literacy education in university library, providing references for university libraries to construct maker spaces and carry out the maker literacy education. [Method/process] This paper tries to summarize and analyze the connotation and definition of the maker literacy. Based on this, using the questionnaire survey method and taking Fudan University as an example, this paper investigates the situation of university students' maker literacy, their attitude to the library maker space and all kinds of maker activities and other basic situations of university library's maker literacy education development. [Result/conclusion] This paper proposes some strategies of carrying out the maker literacy education including actively creating the hardware environment that meets the needs of our users, establishing a diversified and flexible maker foundation course system, building a guiding service system, and encouraging students to organize themselves.

Keywords: university library; maker literacy education; maker space

Note: Figure translations are in progress. See original paper for figures.