GENERAL ARTICLE

Research and Creative Activity in the Design Field

Intersections of Science, Art, and Engineering

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ABSTRACT

This case study assesses the development of research competence among graduate design students through a Ukrainian–Chinese English-language remote learning program. The quasi-experimental study included one group of 19 students who enrolled in the course, titled "Research Methodology and Modern Technology of Design Activity." The extent to which the course improved their confidence in using the English language and their self-assessed readiness to engage in professional activities at the intersection of science, design, and engineering were used as the outcome measures. After 3 weeks of the program, all students reported improved readiness to participate in the scientific community through the English language, demonstrating their ability to perform research and creative activity in the field of design.

In the rapidly evolving global educational, technological, and environmental landscape, there is an increasing demand for highly competent professionals equipped with interdisciplinary skills and knowledge. This demand is particularly evident in the field of design, where the intersections of science, art, and engineering have the potential to drive innovation and address complex challenges. As such, fostering research competence among future graduates in design is paramount for preparing them for successful careers in an international context.

Scientists have conducted research on various aspects of preparing future masters for research activities. This includes investigating the problem of readying students for research activity, exploring innovative technologies for training designers, discussing the use of digital tools in education and distance learning, and focusing on the training of students in English-language projects. The need for such studies is supported by Malina et al. and Davies [1,2], who highlight the transformative impact of interdisciplinary work in the sciences, engineering, arts, and design on economic, cultural, and learning contexts, as well as the importance of developing research competence among design students in master's programs.

Prokopenko et al. substantiate the relevance of research activities and digital technologies in the evolution of higher education institutions to modern digitalized universities [3]. A survey of Chinese master's students shows the importance of effective interaction between the student and the supervisor in undergraduate programs, as well as creative self-efficacy in student research activities [4]. Additionally, conducting a survey of postgraduate students, Kim and Lee found that involving graduate students in scientific projects and including the study of research methodology in their coursework has a positive effect on their scientific success [5]. These findings are supported by those of Paradise and Dufrene [6], who report that involving master's students in the scientific activities of research groups improves investigative outcomes.

The ability to review scientific literature is one of the important competencies of a researcher. However, the difficulty faced by master's and doctoral students in writing literary reviews suggests the need to teach graduate students how to perform this task [7].

A number of studies are devoted to modern teaching methods for training future designers. Shuhailo and Derkach advocate using project- and problem-oriented learning technologies to develop the creativity of design specialists [8]. A study by Skliarenko et al. considered the development of creativity as an element of art therapy used to help students cope with social isolation during the COVID-19 pandemic [9]. Studying the experiences of students enrolled in the master's program of sustainable design at Kingston School of Art, Micklethwaite explores the contemporary socioeconomic aspects of preparing designers to create sustainable objects [10]. Investigating the application of design practice to inter-

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disciplinary fields [11], particularly that of digital learning, Hautopp and Buhl argue for the importance of drawing as a necessary tool in academic dialogue and the collaborative design of digital visual content for higher education. The use of digital tools by design specialists and during technological training is described by Kolosnichenko et al. [12], while Masek et al. review the tools that teachers in Malaysia and Indonesia prefer to use in distance education [13].

Since communication between the student and the supervisor is important during training, it is necessary to justify the choice of online platforms for organizing such interaction. In their study of the communication between students and supervisors, Dong et al. conclude that social networks provide an opportunity for effective discussion [14]. Wang et al. describe the successful use of the WeChat social network in teaching English to high school students in China [15].

The organization of remote learning for students causes some problems associated with the lack of face-to-face interaction between the course developer and the learner. Xie, Rice, and Griswold outline the obstacles faced by online design instructors [16], while Matthews et al. focus on the need to consider empathy when creating online courses and, in particular, the activities of instructional designers [17]. White, White, and Borthwick highlight the roles of participants in the development of massive open online courses, including "learning designers and other seemingly peripheral actors" [18].

Training non-native-English-speaking students of various fields through English-language projects is a topical area of research. The experience of training students in chemical engineering during the international English-language educational project at Kyiv College, Qilu University of Technology, is summarized in an article by Gryshchenko et al. [19]. They found that teaching in a foreign language increased the mental strain of students and that the instructors avoided using many channels of information to prevent cognitive overload among their students. Based on interviews with 11 non-English-speaking students enrolled in English-taught programs in Finland, Calikoglu highlights the academic, social, financial, and psychological problems of teaching international students in non-native-English-speaking countries [20]. Meanwhile, Cabral-Cardoso found the attitude of participants in teaching and scholarly writing programs toward the Englishizing of higher education tended to be ambiguous [21]. The challenges of teachers in Batam, Indonesia, who did not major in English, are outlined in a study by Kaprawi [22].

The purpose of this article is to describe the experience of developing the research competence of graduate design students in a Ukrainian-Chinese educational program conducted in English.

RESEARCH METHODOLOGY

The Ukrainian-Chinese International Educational Project

This study was conducted in 2022 at the Kyiv Institute of Qilu University of Technology, which is located in Jinan, Shandong province, China. The institution was established jointly by Qilu University of Technology and Kyiv National University of Technology and Design in 2019. The institute trains bachelor's students in design, biotechnology, bioengineering, chemical technology, and engineering, as well as master's students in design and pharmaceutical sciences. All programs are taught in English. In 2022, Qilu University of Technology inaugurated its design educational program. Training was provided by teachers from Ukraine and China for whom English was a second language. Hence, the research conducted to improve the training of design students in English formed part of a broader international English-language project. A special feature of the study is that English was the second language for all participants—both the teachers and the students. The research design was quasi-experimental with one group.

Participants

The study included 19 students (eight women; age, 22–42 years) in the master's design program at the Kyiv Institute at Qilu University of Technology. All participants voluntarily participated in the study, and their answers to a survey conducted at the end of the study were submitted anonymously.

Methodology for the formation of research competence in an international English-language educational project

Research competence was developed through classroom and extracurricular activities: namely, lectures, homework, preparing theses and reports to be presented at scientific conferences, and writing scientific articles. All these teaching methods were used in the course "Research Methodology and Modern Technology of Design Activity" (RMMTDA), a three-credit, 90-hour course developed by the authors of the study. Informed by the example and heritage of the brilliant artist, scientist, and inventor Leonardo da Vinci [23], this course presented research and creative activity in design as an intersection of the fields of science (theory, analysis of scientific literature, scientific research, and data analysis), art (analysis of the aesthetic properties of prototypes of design products: their shapes, colors, textures, and compositional means), and engineering (inventory and analysis of patents).

In the RMMTDA course, students studied six areas:

1. Science as a sphere of human activity: components of scientific research, types of scientific work, and the main stages of scientific research.
2. Review of scientific literature in modern research: inventory of literature on the topic of scientific research using electronic databases and international citation standards.
3. Research methodology: research ethics, classifying theories, survey research, descriptive statistics and exploratory data analysis, and methods used by scientists and designers that evoke Leonardo da Vinci's artistic, engineering, and scientific heritage.
4. Specifics of designing complex objects: modern research and methods of design.
5. Publication, testing, and implementation of research results: preparation of scientific reports, articles and abstracts in a professional scientific publication, and speeches at scientific conferences.

6. Fundamentals of intellectual property and global patent databases.

Homework includes the following: analyzing a scientific article; choosing a research topic; assessing the quality of research and identifying substantive reports; determining the purpose, object, and subject of scientific research; performing literary reviews in the chosen field of research; analyzing experimental data; analyzing prototypes; preparing an article; preparing a speech for a scientific conference; and researching patents related to the selected topic. As a creative assignment, the students were tasked with finding and analyzing prototypical design solutions according to the subject of each student's area of research: e.g. corporate identity, interiors, industrial products, websites, textiles, clothing, packaging, etc.

When choosing the forms and methods of training, two negative factors were considered. First, due to the COVID-19 pandemic and quarantine measures taken in China, training was performed using remote technologies. The video conferencing platform Zoom was used to conduct lectures. Students and teachers exchanged short messages through WeChat, and Moodle was used as an online platform for conducting exams, storing educational materials, and submitting homework.

The second factor that influenced the study was Ukraine's declaration of martial law after it was invaded by Russian forces. For this reason, the schedule was adjusted, and the start of the RMMTDA program was postponed from February 28, 2022, to April 11, 2022. Classes were held for three weeks, with 16 hours of lecture held per week, from 11 April to 30 April 2022.

Content and organization of the participant survey

As our research only considers the inaugural year of the RMMTDA program and does not include a control group, it may be considered a case study.

A survey conducted was sent to the student by email after their completion of the program to collect demographic data and responses to both open and closed-ended questions in English. The former requested the students to suggest improvements to the RMMTDA course, while the closed questions asked the students to rate the following: their readiness to conduct scientific activities before and after taking the RMMTDA course, the usefulness and difficulty of the course, and the difficulties in using the English language to complete the course.

The students' readiness to engage the scientific community was assessed by their self-perceived preparedness to engage in the following activities at the intersection of science, art, and engineering: evaluate the relevance and determine the objective of scientific investigations; find and analyze scientific literature; obtain and analyze the results of consumer and expert surveys (experimental data); analyze prototypes of design products; inventory patents; write scientific reports or articles; and prepare conference papers and presentations. The students were asked to determine their readiness for these activities before and after their completion of the RMMTDA course on a five-point Likert scale, where a score of 1 indicated "completely not ready"; and 5, "fully ready."

Students also used five-point Likert scales to assess the usefulness of the course for professional development (1, not useful; 5, very useful), the difficulty of taking the course in English (1, very difficult; 5, very easy), and the impact of taking the course on their level of English proficiency (1, did not affect; 5, greatly improved). The survey further included a list of topics and asked the students to select the one that was most interesting to them and the most useful to their design and research activities.

Results

The diagrams presented in Figures 1–6 show the results of the students' self-assessments of their readiness to carry out scientific activities before and after taking the RMMTDA course.

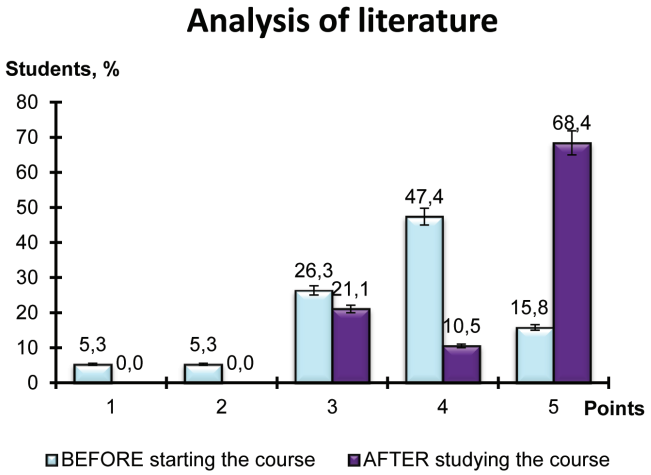

Fig. 1. Results of the students' self-assessed readiness for the inventory and analysis of scientific literature. The diagram shows relative error bars of 5%.

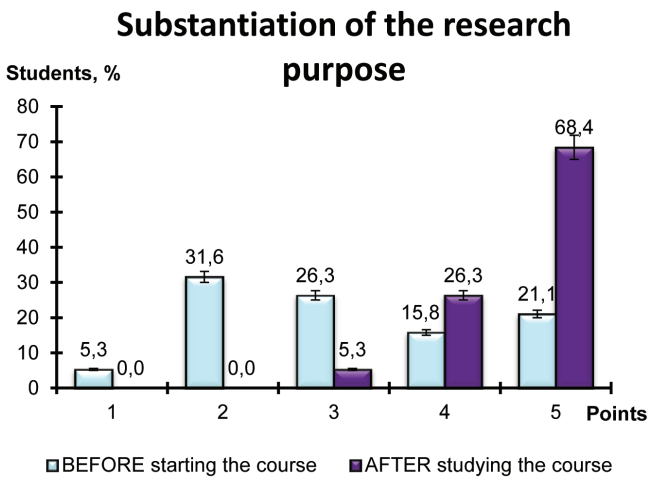

Fig. 2. Results of the students' self-assessed readiness to evaluate the relevance and determine the objective of scientific investigations. The diagram shows relative error bars of 5%.

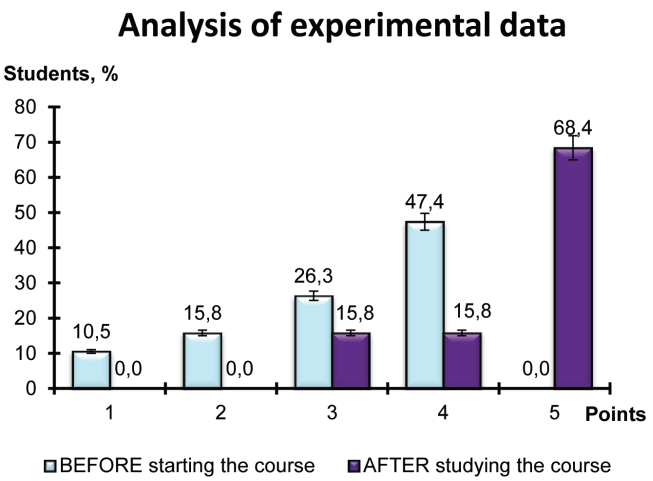

Fig. 3. Results of the students' self-assessed readiness to conduct and analyze the results of consumer and expert surveys (experimental data). The diagram shows the relative error bars of 5%.

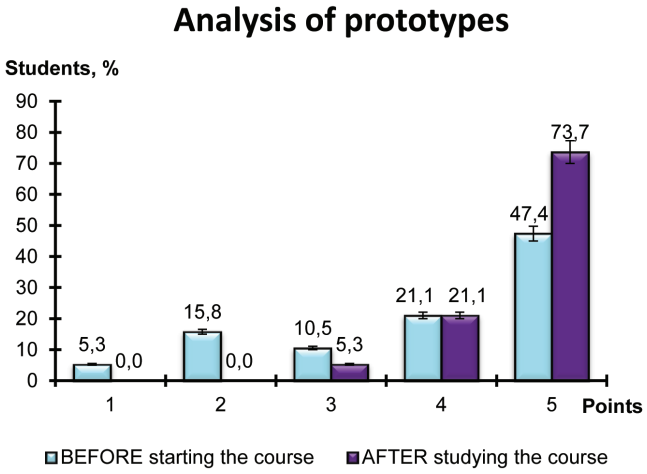

Fig. 4. Results of the students' self-assessed readiness to analyze prototypes of design products. The diagram shows relative error bars of 5%.

The readiness of students to engage in all the activities covered in the RMMTDA program increased as a result of completing its curriculum. The percentage of students who rated their level of readiness to inventory and analyze scientific literature at the highest score of 5 increased from 15.8% before their enrollment in the program to 68.4% after completing it (Fig. 1). The percentages of students who rated their readiness scores of 1, 2, 3, and 4 decreased from 5.3% to 0%, 5.3% to 0%, 26.3% to 21.1%, and 47.4% to 10.5%, respectively.

Figure 2 demonstrates that the percentage of students who rated their level of readiness to evaluate the relevance and determine the objective of scientific investigations scores of 4 and 5 increased from 15.8% to 26.3% and 21.1% to 68.4%, respectively. The percentages of students who rated their readiness scores of 1, 2, and 3 decreased from 5.3% to 0%, 31.6% to 0%, and 26.3% to 5.3%, respectively.

The diagram presented in Fig. 3 shows that the percentage of students who rated their level of readiness to conduct and analyze the results of consumer and expert surveys (experimental data) a score of 5 increased greatly from 0% to 68.4%. The percentages of students who rated their readiness scores of 1, 2, 3, and 4 decreased from 10.5% to 0%, 15.8% to 0%, 26.3% to 15.8%, and 47.4% to 15.8%, respectively.

As shown in Fig. 4, the percentage of students who rated their level of readiness to analyze design prototypes a score of 5 increased from 47.4% to 73.7%. The percentage of students who rated their readiness level a score of 4 did not change (21.1%), and those of students who rated their readiness scores of 1, 2, and 3 decreased from 5.3% to 0%, 15.8% to 0, and 10.5% to 5.3%, respectively.

Figure 5 shows a more than tenfold increase in the percentage of students who rated their level of readiness to write scientific reports and articles a score of 5 (from 5.3% to 57.9%). The percentage of students who rated their readiness level a score of 4 also increased, although less dramatically (from 31.6% to 36.8%). The percentage of students who rated their readiness scores of 1, 2, and 3 fell from 5.3% to 0%, 10.5% to 0%, and 47.4% to 5.3%, respectively.

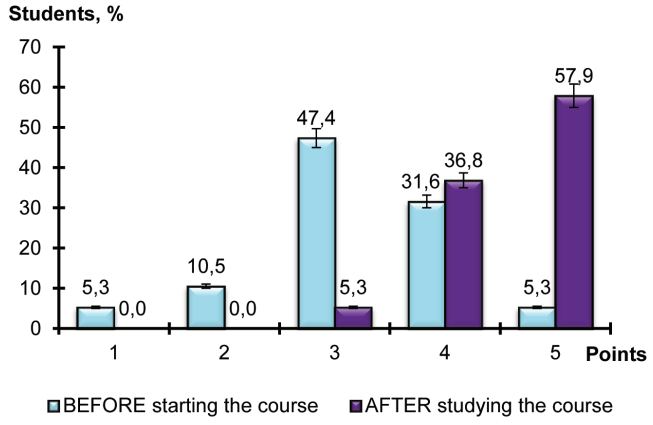

Fig. 5. Results of the students' self-assessed readiness to write scientific reports and articles. The diagram shows relative error bars of 5%.

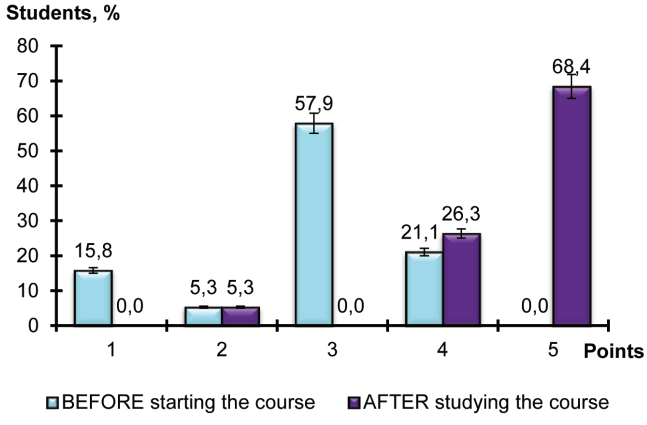

Fig. 6. Results of the students' self-assessed readiness to inventory and analyze patents. The diagram shows relative error bars of 5%.

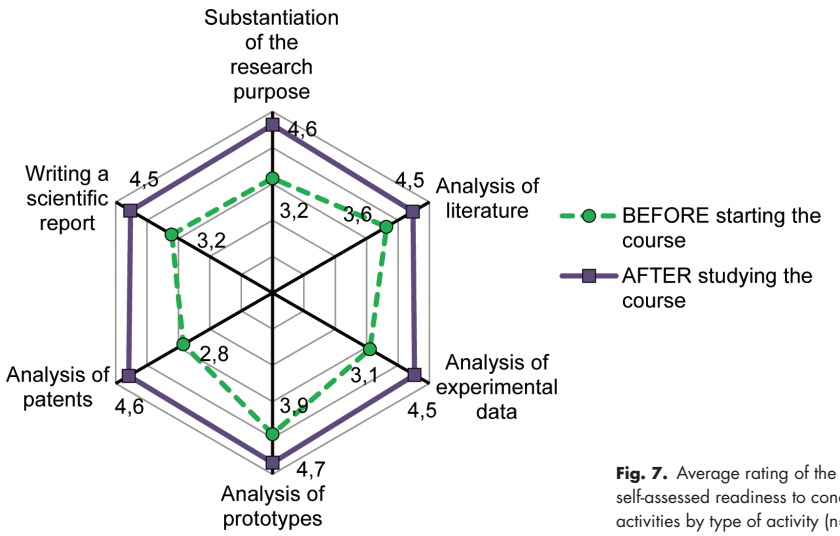

Fig. 7. Average rating of the students' self-assessed readiness to conduct research activities by type of activity (n=19 students).

Figure 6 shows that none of the students rated their readiness to find and analyze patents a score of 5 before enrolling in the RMMTDA course. The percentage of students who rated their readiness a score of 5 was 68.4% upon completion of the program. The percentage of students who rated their readiness level a 4 increased slightly from 21.1% to 26.3%. The percentage of students who rated their readiness a score of 3 declined from 57.9% to 0%, and that of students who submitted a score of 2 (5.3%) did not change. Before taking the course, 15.8% of the students rated their readiness the lowest score of 1. No student submitted a score of 1 at the end of the program.

We calculated the average of all scores to gauge the change in the students' readiness to engage in scientific activities across their enrollment in the RMMTDA course. Our results are shown in a radar chart (Fig. 7).

As a result of taking the RMMTDA course, the average rating for the students' self-perceived readiness to perform each activity increased. The largest increase, from 2.8 to 4.6 points (a difference of 1.8 points), was seen in their readiness to inventory and analyze patents. The smallest increase, from 3.9 to 4.7 points (difference of 0.8 points), was observed in their readiness to analyze design prototypes.

The students' assessments of the usefulness of the RMMTDA program for professional development, difficulties in taking the course in English, and the impact of taking the course on English proficiency are shown in in Fig. 8. All students found the RMMTDA course useful for professional development: 11% of respondents rated the course's usefulness a score of 4, and 89% considered it "very useful" (5).

Regarding the difficulty of taking the course in English, 5% considered it to be very difficult (a score of 1), 26% found the difficulty to be average (a score of 3), 5% reported that it was easy to take the course in English (a score of 4), and 63% considered it to be very easy (5). All students believed that taking the RMMTDA course improved their level of English proficiency. An average degree of improvement (a score of 3) was reported by 21% of students; a very high degree of improvement (a score of 5), by 79%.

In response to the open-ended question as to how the RMMTDA course could be improved, students expressed their gratitude to the instructor for the clear presentation, their slow pace of speaking during lectures, and the professionally useful content. One student wrote that though English was difficult for him, the way the course was conducted made the English content easier to learn.

Another positive outcome of the study was that all of the students participated in the Fourth International Scientific and Practical Conference, Topical Issues Of Modern Design (Kyiv, Kyiv National University of Technologies and Design, 2022). Eleven students attended as observers, while eight presented their reports and published theses in collaboration with teachers and other students at Kyiv National University of Technologies and Design. Abstracts published by the students covered a variety of areas: trends in smart clothing for older adults, Chinese characters in modern design, logos in brand design, the poster as a means of social advertising in the context of the COVID-19 pandemic, and packaging design for organic agricultural products.

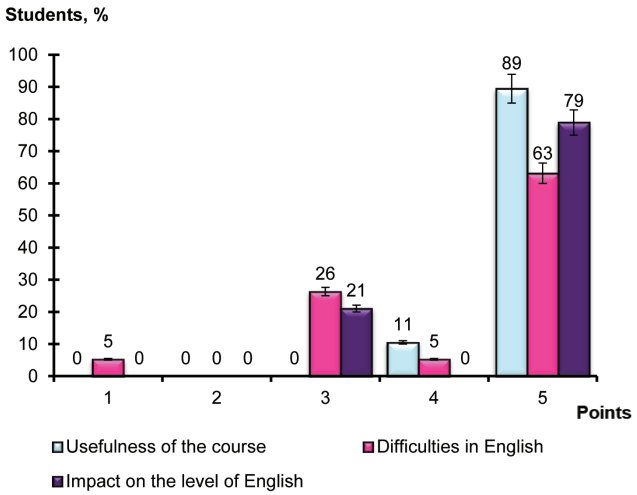

Fig. 8. Results of students' assessments of the usefulness of the RMMTDA course for professional development and the impact of the course on the level of English proficiency. The diagram shows relative error bars of 5%.

DISCUSSION OF RESULTS

The results of the study generally confirm the findings of previous scientific studies of developing research competency and teaching in English as a second language.

The survey showed that, as a result of taking the RMMTDA course, the students' self-perceived readiness to engage in research activity of all types increased. This finding agrees with the conclusions of Kim and Lee regarding the effectiveness of graduate instruction in research methodology [24]. The largest improvement of 1.8 points in finding and analyzing patents may be due to the fact that students did not work with patent documentation before enrolling in the course. Their self-assessed readiness to analyze design prototypes improved the least (0.8 points). We attribute this to the fact that a designer routinely analyzes prototypes in their work; hence, this task was likely familiar to the students before their enrollment.

It is important that all respondents considered the RMMTDA course to be useful for their professional development. This finding confirms the relevance of research competence in graduate design students, as substantiated by Davis [25].

The survey showed that students generally believed the difficulties in studying a course in English to be insignificant. Furthermore, all respondents considered their level of English proficiency to have improved as a result of attending the course. These results agree with the those of Gryshchenko et al. [26], who recommended the use of a limited amount of information to avoid cognitive overload of non-English-speaking students in an English-language educational program.

The students' assessments of the effectiveness of using distance learning technologies in a pandemic confirms the results of Masek et al. [27], who found that Indonesian lecturers consider their university's learning management system to be effective. Our findings also help to validate the observation of Dong et al. that social networks (in this case, WeChat) can effectively facilitate communication between students and teachers [28].

The present results do not, however, verify the conclusions of Cabral-Cardoso concerning the resistance to learning and academic writing in English in non-English-speaking countries [29].

This study suggests that research competence can be proficiently developed within the framework of an international English-language educational project implemented through distance learning technologies. We consider it appropriate to continue such projects and introduce similar projects in other specialties and at different levels of education.

CONCLUSIONS

The RMMTDA course is unique insofar as it presents research and creative activity in the field of design as an intersection of the fields of science, art, and technology. The present case study of the RMMTDA's inaugural year demonstrates the effectiveness of developing research competence among graduate design students in an international Ukrainian-Chinese English-language educational project.

As a result of taking the RMMTDA course, the average scores of the students' readiness to engage in all of the following activities increased: evaluating the relevance and determining the objective of scientific investigations; finding and analyzing scientific literature; conducting and analyzing the results of consumer and expert surveys (experimental data); analyzing prototypes of design products; finding and analyzing patent documents; writing scientific reports and articles; and preparing conference papers and presentations. The largest increase of 1.8 points was observed in the students' self-assessment of their readiness to inventory and analyze patent documents; the smallest increase of 0.8 points, in their readiness to analyze prototypes of design products.

All students surveyed found the RMMTDA course useful for professional development. The further survey showed that students generally believed the difficulties in studying a course in English to have been insignificant. Concurrently, all students believed that studying the RMMTDA course improved their English proficiency.

Another positive outcome of this course was that all students participated in the international scientific conference and published abstracts of their reports.

The results of this study help to further develop international English-language education for students and specialists in the field of design, as well as their competence in the global scientific community. Future research endeavors will center on the resurgence of face-to-face pedagogy in a post-pandemic era. The imminent integration of the RMMTDA course into conventional classroom instruction presents an opportunity for comparative analysis between outcomes derived from distance learning and traditional face-to-face methodologies.

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