Comparative Analysis Remote Sensing Course Teaching between China and Thailand

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Abstract. The analysis aims to do the survey and needs analysis concerning designing a new innovative learning platform, a Learning Management System (LMS) for Asian countries, China and Thailand. In order to establish a remote sensing learning management system, Chinese and Thai RS educators, scholars, and professionals were selected to answer a survey about RS course content, objectives, methods, and assessment. The resulting insights were as follows: (i) The significant problems in RS teaching are primarily found in teaching and assessment methods. While teaching is mainly based on the "Lecture-Based Learning" method and "Case Methods of Teaching", assessment methods are typically single. (ii) The similarities between Chinese and Thailand RS education attach significance to teaching RS principles and applying fundamental knowledge in technology application. (iii) China and Thailand are satisfied with existing RS courses and aspire to develop future RS teaching in a comprehensive, innovative, and application-oriented manner.

Keywords: Management System; Remote sensing education; Comparative study; Teaching methods; Teaching assessment; IRSEL

1 Introduction

Remote sensing subject education is vital in developing the remote sensing high-tech industry [1]. It is also crucial support for the Geographic Information System (GIS) field [2], which holds a critical position in the field of geosciences [3]. As a professional application course [4], [5], the remote sensing course is the sum of the teaching content and teaching plan design chosen by schools and other educational institutions to attain

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the training objectives of remote sensing majors and others, teach the principles of remote sensing, and remote sensing image processing technology, primarily to cultivate students' ability to apply remote sensing technology.

The current research on remote sensing courses in China mainly focuses on the teaching reform of remote sensing courses. The reform content revolves around the teaching content, means, and assessment methods [6], [7] and analyses the problems in questionnaire survey found that the common issues of remote sensing teaching are primarily depicted in the teaching content, teaching methods, evaluation, such as the obsolescence of remote sensing teaching materials and the development progress of remote sensing technology, and the lack of unique experimental teaching materials [2]. Of note, there are more theoretical and less experimental courses, and the teaching model is more traditional [8]. Besides, the assessment is primarily based on the theoretical written test, and the form is relatively straightforward [9]; Thus, assessing the students' practical application ability is challenging.

Nevertheless, with the help of the network platform, the innovative teaching mode platform is developing online [10], [11], such as "MOOC" (Massive Open Online Course; https://www.icourse163.org/), "zhihuishu" (https://www.zhihuishu.com/), and "ULearning" (https://www.ulearning.cn/). Moreover, during COVID-19, using the "Tencent Meeting" to teach and report is very convenient and avoids crowds. They all are integrated with numerous premium online courses. E-learning has an advantage, which has the characteristics of openness and sharing. However, compared with traditional curriculum teaching, it lacks interactivity, and it is challenging to evaluate students' learning effects comprehensively. The teaching mode, such as "Flipped Classroom" [12] and "CDIO" (Conceive, Design, Implement, Operate) [13], reflects the diversification of teaching reform and innovation. Although some progress has been made in the teaching reform of remote sensing courses, there is still a lack of a systematic remote sensing course learning management platform for students to learn remote sensing knowledge independently.

Thailand is the remote sensing center of Southeast Asia, and its remote sensing career has been highly influential in Southeast Asia and Asia overall. Thailand has Thailand Remote Sensing Center and other platforms and has held various international seminars on remote sensing. The country has rich experience in remote sensing education and teaching and research projects [14].

Despite some similarities in the teaching mode of remote sensing between China and Thailand, there are a few comparative studies on remote sensing education in be-tween. Thus, the comparison and demand analysis of remote sensing education be-tween China and Thailand is essential to elucidate the existing problems and build LMS in remote sensing education. It can not only stimulate the exchange of under-graduate/postgraduate advanced remote sensing education and teaching between the two countries and enhance teaching effectiveness but also complement the comparative study of remote sensing education between China and Thailand. Moreover, the gaps and innovative teaching methods help strengthen the cooperation in remote sensing scientific research between the two and complement each other. Meanwhile, it provides insights for high-demand courses in the field of integration of remote sensing in the IRSEL project to develop a new module in remote sensing education.

2 Study Design

2.1 Study Objects

IRSEL is a project determined to build a high-quality remote sensing learning management system platform for higher remote sensing education. IRSEL partners include the Obuda University, Austrian University of Natural Resources and Life Sciences, Jagiellonian University of Poland, University of Twente of the Netherlands, Fujian Normal University, Yunnan Normal University, Asian Polytechnic University of Thailand, and Khon Kaen University. The project establishes an innovative learning platform for Asian countries that carry out related activities in the field of remote sensing. Therefore, the remote sensing education-related researchers in China and Thailand are represented to carry out the remote sensing teaching demand survey. The objects of the questionnaire survey were primarily engaged in teaching, research, and learning of remote sensing majors. Based on the rich teaching experience of professional scholars, remote sensing application experience, and familiarity with remote sensing education disciplines, we aimed to enhance the teaching quality of remote sensing education, better build a remote sensing teaching platform and provide targeted opinions and suggestions. We distributed 173 electronic questionnaires, including 35 from Chinese universities and 51 from corporate companies, and 87 from Thai universities. Of these, there are 37 doctors, 32 masters, and 17 undergraduates in Chinese universities and corporate companies. The questionnaire star was used as a sur-vey technique to distribute and retrieve the questionnaire. The questionnaire response rate is 99%.

2.2 Research Dimensions and Survey Questions

Multiple factors, such as education level conditions and teaching experiment facilities, improve remote sensing education and teaching quality. Thus, it is essential to seize the critical problems in remote sensing teaching to conduct a questionnaire sur-vey to enhance the remote sensing teaching quality with the theme of "Remote Sensing Course," finding the contents of RS education research mainly involved "teaching re-form," "teaching method," "teaching model," "practical teaching," and another key-word [15], [16], depicting the continuous reform of remote sensing curriculum education and focusing on remote sensing teaching methods and teaching models cultivation of applied talents of remote sensing technology. Thus, the questionnaire design for the comparative study of remote sensing education in China and Thailand revolved around the research hotspots of remote sensing courses, which mainly included the following: teaching courses, course standards, teaching methods, assessment evaluation standards, and course satisfaction (Fig.1). And more details are on the website: https://www.wjx.cn/jq/19156935.aspx.

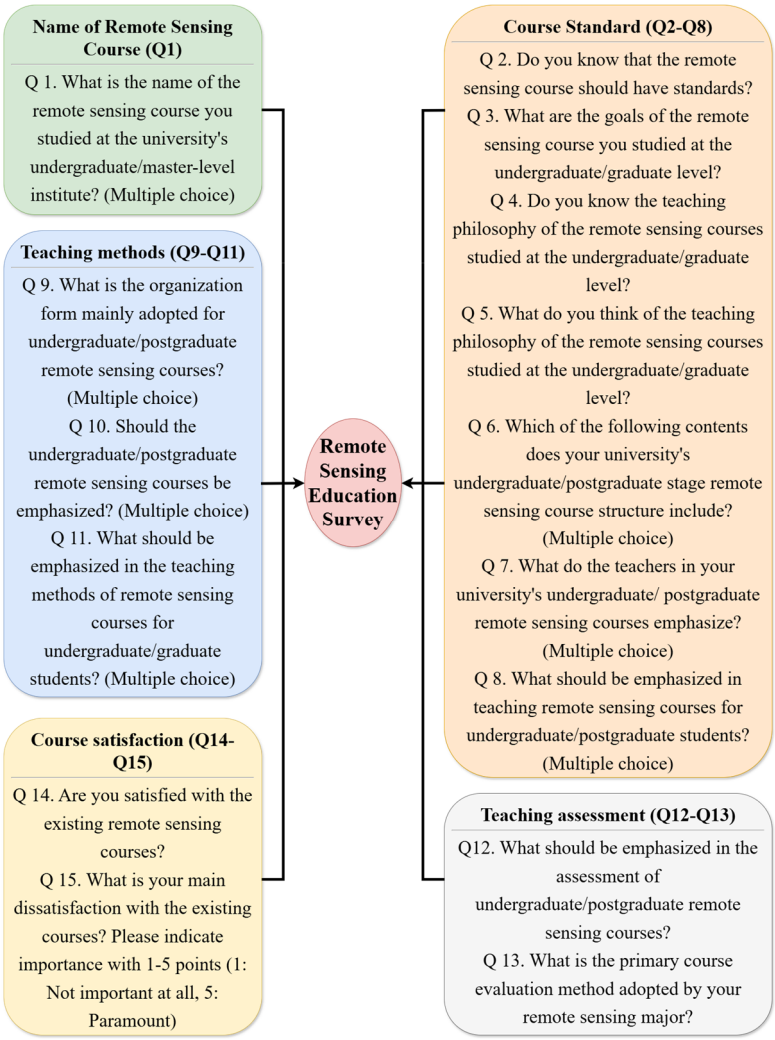

Fig. 1. Questionnaire survey of remote sensing course education.

3 Results

3.1 Remote Sensing Course

The current remote sensing courses colleges and universities offer primarily include the following three major categories: remote sensing principles, remote sensing technology applications, and remote sensing special applications. In the questionnaire, remote sensing principles courses mainly included the following: Introduction to Re-mote Sensing, Remote Sensing Principles and Applications, Remote Sensing Principles and Methods; Remote Sensing Technology Application Courses included the following: Remote

Sensing Technology, Remote Sensing Technology and Application, Remote Sensing Digital Image Processing, Remote Sensing Mapping and other courses; Remote sensing thematic applications included the following: remote sensing geoscience analysis, remote sensing of land resources, forestry remote sensing, and resources and environmental remote sensing. From the comparison results of remote sensing courses offered by Chinese and Thai colleges and universities (Fig. 2), the similarity in the two in undergraduate/postgraduate remote sensing education and teaching lay in the emphasis on remote sensing principles courses and the fundamental remote sensing im-age processing technology, but less special thematic remote sensing application courses. The subtlety is that remote sensing education in Thai colleges and universities emphasizes the introduction of remote sensing, supplemented by courses on remote sensing principles and remote sensing digital image processing. In contrast, Chinese colleges, and universities focus on remote sensing digital image processing, remote sensing principles, and other courses. Regarding the guiding role of students, we found that with the development of remote sensing technology and the needs of social applications, colleges, and universities also focus on training students' professional remote sensing skills and learning of remote sensing technology methods. Thus, it is crucial to increase the proportion remote sensing technology application courses, focus on com-piling practical textbooks [17], and emphasize cultivating students' enthusiasm for learning, such as remote sensing auxiliary reference books and special case libraries.

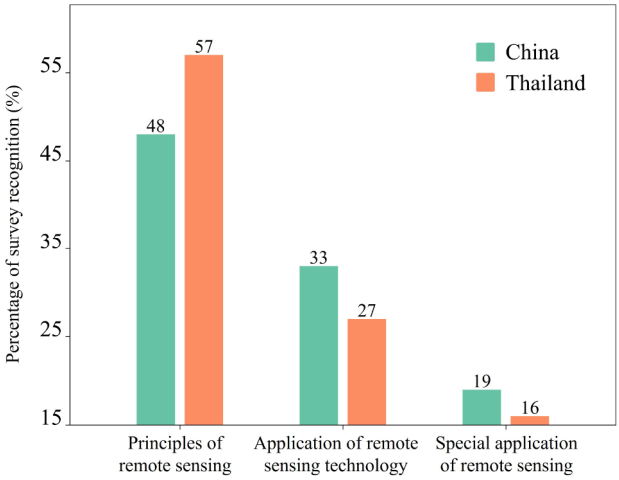

Fig. 2. Comparison of remote sensing courses (%).

3.2 Standard of Remote Sensing Course

Curriculum standards are the basic norms of the curriculum and programmatic documents that guarantee to teach quality, which is equivalent to the syllabus in traditional teaching. Our survey elucidated remote sensing education curriculum standards in China and Thailand from the perspectives of remote sensing curriculum standards, objectives, and teaching concepts. Figure 3 shows the survey results, which demonstrate

that both countries know the standards of remote sensing courses, but they learn the objectives of remote sensing courses slightly differently. For example, the objectives of remote sensing teaching in Chinese universities are to enable students to master the fundamental principles of remote sensing imaging and image processing and to recognize remote sensing. The significance of technology in geosciences and GIS applications is primarily at 62%, illustrating the critical role of remote sensing technology in geosciences applications, followed by enabling students to cultivate students practical ability based on theoretical learning. In addition, the application of remote sensing technology for resource and environmental surveys reached 36%.

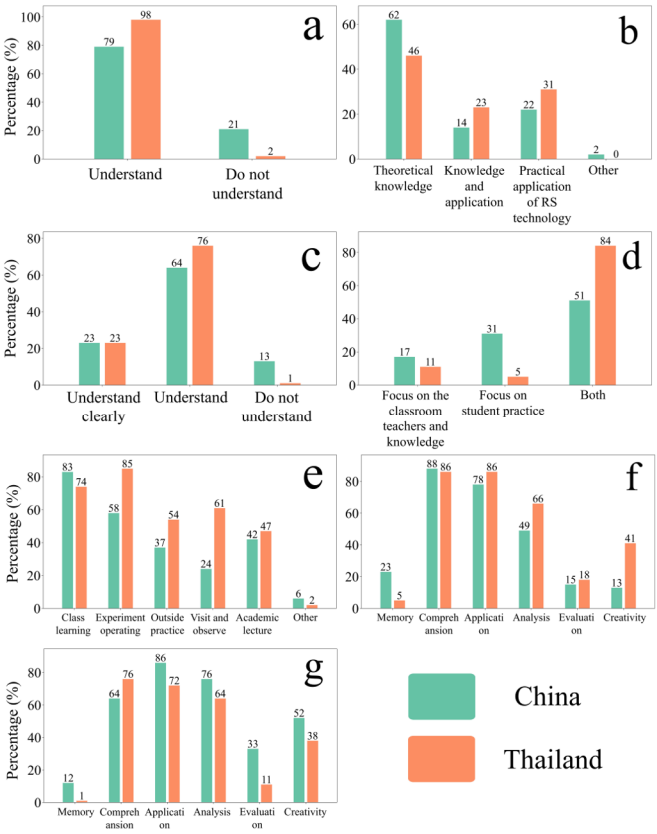

Fig. 3. Comparison of curriculum standards of remote sensing education (%). (a) Do you know if the remote sensing should have course standards? (b) What are the goals of the remote sensing course you studied at the undergraduate/graduate level? (c) Do you know the teaching philosophy of the remote sensing courses studied at the undergraduate/graduate level? (d) What do you think of the teaching philosophy of the remote sensing courses studied at the undergraduate/graduate level? (e) Which of the following contents does your university's undergraduate/postgraduate stage re-mote sensing course structure include? (f) What do the teachers in your university's undergraduate/postgraduate remote sensing courses emphasize? (g) What do you think should be emphasized in the teaching of remote sensing courses for undergraduate/postgraduate students?

Regarding Thai colleges and universities, the objective of the remote sensing curriculum is more balanced, that is the education of theoretical knowledge and the cultivation of student's ability to use remote sensing technology to conduct related re-search work. Both countries understand teaching concepts, but the degree of clarification of the teaching concepts of remote sensing is not high. Both believe that the teaching concept should be centered on the classroom, teachers, knowledge, and student practice, that is, to realize the CDIO engineering teaching mode. Our survey results were relatively similar in terms of curriculum structure. Both are based on class-room lectures, special operations, academic lectures and units, and field internships. Thai universities focus more on remote sensing teaching visits and observations, emphasizing student acquisition indirect experience.

Regarding the emphasis on remote sensing education and teaching, both currently focus on students' understanding, application, and analysis of remote sensing curriculum education. In the future, they would also develop students' understanding, application, and analysis of remote sensing learning and cultivate students' creative learning ability and independent research abilities. However, the remote sensing curriculum standards remain in the understanding and application of knowledge and lack of cultivation of students' creative thinking. Thus, it is crucial to strengthen the application-oriented curriculum standards and make the curriculum standards develop to the "knowledge + project" type to improve the student's practical ability to apply remote sensing technology.

3.3 Teaching Methods of Remote Sensing Courses

Teaching methods imply the process in which teachers use different methods to enable students to directly or indirectly acquire knowledge, augment learning ability, and acquire learning methods. Different teaching methods exert different teaching effects. We compared and analysed the differences in remote sensing teaching methods between China and Thailand regarding the organizational form, emphasis on learning methods, and teaching methods of remote sensing education and learning methods. Figure 4 shows the survey results, which demonstrate that both countries are primarily based on theoretical lectures and computer experiments regarding learning organization. Besides, Chinese universities often conduct remote sensing teaching with case presentations, problem discussions, and project research.

Regarding emphasis on learning methods, both attach significance to the class-room group activities, extracurricular group activities, and remote sensing projects to study learning methods. At the same time, use the advantages of network learning for teaching. Chinese colleges and universities emphasize the significance of remote sensing project research in teaching, which is an expression of cultivating students' com-prehensive learning ability and depicts students' professional knowledge. Regarding emphasis on teaching methods, both attached significances to expanded training based on textbooks and applied teaching to make remote sensing teaching closer to practical applications. We found that the teaching mode of remote sensing courses at the emerging stage is still dominated by the mixed mode of "classroom + hands-on experiment." It

is challenging to embody personalized and multilevel teaching, and students accept remote sensing knowledge passively. Thus, in terms of teaching method reform: before class, the "flipped classroom" mode [18] and the "MOOC" education platform can be used to perform pre-class preview; In the classroom, the form of "questioning," "interactive," and "discussing" is adopted [19], and teaching is conducted with students as the main body, and the roles of teachers and students are switched. After class, individualized training of groups is project-oriented [20], quickly mastering learning methods through experiments [21] and the use of "Microlecture" to strengthen the re-view of crucial knowledge, to harness students' inquiry learning ability, as well as achieve full coverage of "before-in-class-after-class," continuously infiltrate remote sensing knowledge and operational capabilities, and reform the teaching model.

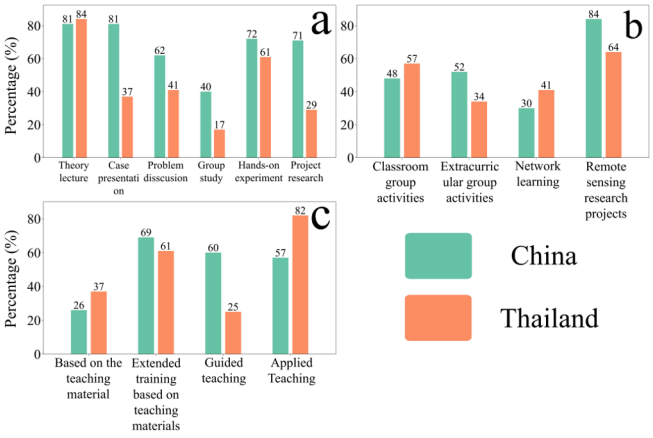

Fig. 4. Comparison of teaching methods (%). (a) What kind of organization form is mainly adopted for the undergraduate/postgraduate remote sensing courses? (b) Should the undergraduate/postgraduate remote sensing courses be emphasized? (c) What should be emphasized in the teaching methods of remote sensing courses for undergraduate/graduate students?

3.4 Teaching Assessment of Remote Sensing Courses

Teaching appraisal is used to assess teachers' teaching effects and students' learning effects. We compared teaching assessment and evaluation methods of remote sensing teaching between China and Thailand (Fig. 5). Both remote sensing teaching assessments of China and Thailand emphasizes the teachers' explanation level and teaching effect, which are equally crucial. The test teaching effect is often presented by the pen-and-paper test, course paper, speech report, and other evaluation methods. The difference is that Chinese colleges and universities mostly use the pa-per-and-pencil test as the primary evaluation method. In contrast, Thai colleges and universities mostly use their works to present the learning effect of remote sensing courses. The single assessment method based on the examination papers is a common problem in assessing remote sensing courses in colleges and universities. The assessment method restricts the development of students' procedural thinking and strategic to a certain extent [22], that

is, the analysis, evaluation, and creation of knowledge. Hence, establishing a diversified evaluation and assessment method, transforming the learned remote sensing knowledge into application-oriented achievements, and enhancing the efficiency of students' learning achievements are vital to the reforming of remote sensing teaching assessment and evaluation. In teaching assessment, process assessment should be the focus. We can use the form of group reports to cultivate students' team spirit and competitive consciousness, as well as create an efficient learning atmosphere.

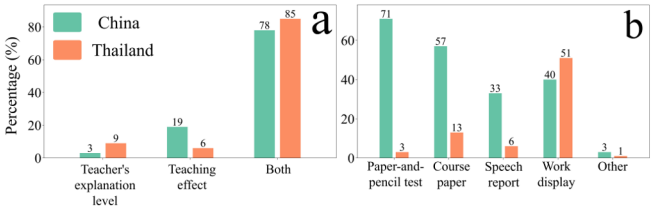

Fig. 5. Comparison of teaching assessment and evaluation (%). (a) What should be emphasized in assessing undergraduate/postgraduate remote sensing courses? (b) What is the primary course evaluation method adopted by your remote sensing major?

3.5 Satisfaction of Remote Sensing Courses

Figure 6 shows Chinese and Thai remote sensing course satisfaction survey results. Chinese and Thai universities are satisfied with the current remote sensing education courses, accounting for 66% and 72% of the course satisfaction, respectively. The difference is that Chinese universities' dissatisfaction accounted for 20%, whereas Thai universities' dissatisfaction accounted for only 2%.

Fig. 6. Comparison of the degree of satisfaction in remote sensing courses (%). (a) China; (b) Thailand

To further explore the causes of "dissatisfaction" of scholars on remote sensing education, comprehend the limitations of remote sensing education at this stage and examine the causes of dissatisfaction, as well as use different scores to score the level of dissatisfaction (1–5 points, expressed the degree as: not satisfied at all-dissatisfied-satisfied-very satisfied-especially satisfied), the results are expressed in mode (Fig. 7). Comparing the reasons why China and Thailand are dissatisfied with the current remote

sensing curriculum, we found that Thai colleges and universities focus more on issues like outdated textbooks, low level of teacher explanations, and fewer practice hours, demonstrating that Thai colleges and universities continue to at-tach significance to remote sensing curriculum education and improve the remote sensing education level. Meanwhile, it also reflects the commonality of remote sensing education in China and Thailand, and the scarcity of software and hardware facilities for remote sensing courses must be resolved. Besides, the respondent proposed several opinions and suggestions on the improvement of the cause of dissatisfaction: (1) When the case is displayed, the application effect is highlighted while the solution is dis-played; (2) With practical teaching as the center, the theory runs through practice, with emphasis on the operability of remote sensing applications, the combination of valuable content, and application prospects; (3)Multidisciplinary exchange learning, expanding the field of remote sensing applications; (4) Conducting seminar-based re-mote sensing courses teaching, inspiring the application of remote sensing technology thinking, and training remote sensing application capabilities.

Reasons for dissatisfaction	China	Thailand
1.Outdated textbooks.	★★★☆☆	★★★★☆
2.The teacher's explanation level is low.	★★★☆☆	★★★★☆
3.The theory is too strong, and there are few hours in practice.	★★☆☆☆	★★★★☆
4.Single teaching method and means.	★★★☆☆	★★★☆☆
5.The traditional teacher-centered teaching concept does not reflect the student-centered modem teaching concept.	★★★☆☆	★★★☆☆
6.Single teaching organization.	★★★☆☆	★★★★☆
7.The teaching implementation equipment is insufficient to meet the requirements.	★★★☆☆	★★★★☆
8.There are few opportunities to participate in remote sensing academic activities (academic reports, academic salons, subject research exchanges).	★★★☆☆	★★★☆☆

Fig. 7. Comparison of reasons for dissatisfaction.

3.6 "IRSEL" Remote Sensing Education Innovation Platform

The IRSEL project, a large-scale international cooperation project, is primarily organized by higher education institutions and aims to promote universities in EU member states to implement remote sensing education, remote sensing academic re-search exchanges, and talent training worldwide. Under this framework, using the latest information and communication technology as a learning management system, a new version of the remote sensing learning management platform has been developed to encourage the professional development of personnel in remote sensing and related disciplines. The platform integrates a total of 20 remote sensing teaching modules, primarily involving remote sensing principles, remote sensing data collection, remote sensing digital image processing, remote sensing technology applications (e.g., agriculture, forestry, and water), urban remote sensing applications, and drone applications [23], [24], thereby embodying the focus and hot topics of remote sensing teaching content and research. The teaching method is mainly based on explaining basic theoretical knowledge, joining the focus of the module content and the practical operation exercises of satellite remote sensing data layout, and receiving the students' feedback

through the discussion area. Meanwhile, the test area in the module primarily examines students' mastery of theoretical knowledge. The main interface of the course (Fig. 8) mainly includes the IRSEL leading directory, user login, and course module. The course module has electronic reference books, video tutorials, and experimental data to facilitate students' integrated operation. Of note, the platform can be found at https://www.itc.nl/education/ website. Furthermore, the project organized summer school training to strengthen teacher skills training to provide a guarantee for the teaching quality of the platform.

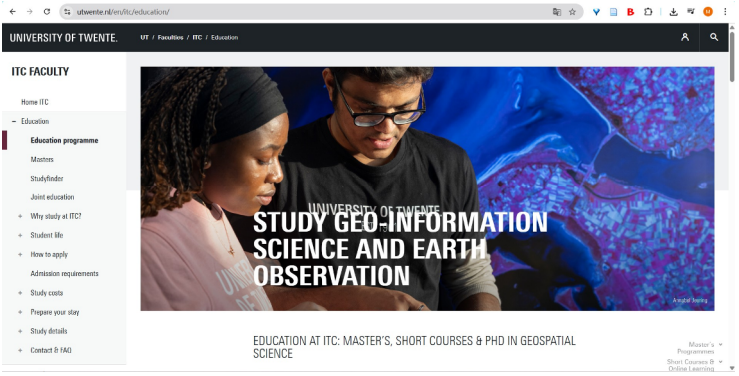

Fig. 8. IRSEL course module main interface.

4 Discussion and Conclusions

4.1 Conclusions

1) The traditional teaching methods and the single assessment method are outstanding issues in the teaching of remote sensing courses, and the reform of remote sensing teaching primarily focuses on the innovation of teaching methods and the reform of teaching methods with the help of the Internet and grasping new trends in remote sensing technology.

2) The similarity of the teaching of remote sensing courses in Chinese and Thai colleges is that both focus on the guiding role of the theoretical basis of remote sensing principles; the teaching mode of combining classroom education and practical education, accentuating the understanding, application, and analysis of remote sensing course learning; and emphasizing the impact of teachers' teaching level and teaching effects on students, the diversified assessment criteria, and comprehensive assessment of learning efficacy.

3) The difference in the remote sensing curriculum education between China and Thailand is reflected in the higher education institutions in Thailand focus more on the setting of the curriculum structure, such as visiting and observing. Regarding teaching assessment, Chinese colleges and universities focus on paper-and-pencil tests, while Thai colleges and universities focus on the display of work. Regarding learning methods, Chinese universities highlight the significance of remote sensing research projects.

4) Chinese and Thai colleges and universities are satisfied with the current remote sensing teaching forms and effects and look forward to the future diversification of remote sensing education forms, the practicality of courses, interdisciplinary intersect, heuristic teaching, and professional competence.

4.2 Discussion

In this study, the comparative investigation of remote sensing teaching in China and Thailand is conducted from remote sensing courses, curriculum standards, teaching methods, assessment and evaluation, and satisfaction with the courses. The survey content corroborated Wang et al. [25] Furthermore, it aimed to elucidate the current teaching status of remote sensing courses, discuss the existing problems, and propose suggestions for improving remote sensing teaching. The differences in remote sensing teaching between China and Thailand also offered a reference for each other's remote sensing teaching. For example, Thai colleges and universities focus on the "work display" assessment method to comprehensively assess students' learning effect, reflecting that "teaching fish is better than fishing"; its efficacy allows us to further reflect on how students learn by rote.

In addition, the survey results provide valuable experience for constructing the IRSEL remote sensing education innovation platform. The innovative platform integrates the knowledge and application system of remote sensing principles, remote sensing technology applications, remote sensing thematic applications, and other aspects, together with the practical operation of remote sensing satellite data to consolidate the learning effect, as well as provide discussion areas to augment the interaction between teachers and students. In addition, it divides the remote sensing course into modules and concentrates it under a platform, which can effectively perform remote sensing teaching to a certain extent. It is an innovative educational platform dedicated to remote sensing teaching. Although the remote sensing courses are rich in content, the teaching methods warrant improvement. For example, how to convey the core in-formation to students in a limited time so that students can effectively absorb the knowledge they have learned particularly important. Thus, it is crucial to refer to the results of the Sino-Thailand remote sensing teaching survey further to diversify the teaching methods and assessment methods of IRSEL and enhance the practical application value of IRSEL. Briefly, the comparative investigation and research of remote sensing teaching play a crucial role in promoting the high-quality development of re-mote sensing teaching, innovating the remote sensing education platform, and enriching the teaching mode. Moreover, it reflects the people-oriented education concept of remote sensing education [26].

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