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International Telecommunication Union
Standardization Sector

Recommendation

ITU-T F.742.1 (12/2022)

SERIES F: Non-telephone telecommunication services

Multimedia services

Requirements for smart class systems based on artificial intelligence

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Recommendation ITU-T F.742.1

Requirements for smart class systems based on artificial intelligence

Summary

Recommendation ITU-T F.742.1 describes application scenarios and requirements for smart class system based on artificial intelligence, including application scenarios, service requirements, management requirements, and security considerations.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T F.742.1	2022-12-14	16	11.1002/1000/15184

Keywords

Artificial intelligence, education, smart class system.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

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The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

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Requirements for smart class systems based on artificial intelligence

1 Scope

This Recommendation specifies requirements for smart class systems (SCSs) based on artificial intelligence (AI), which specifically describe the scenarios and requirements.

The scope of this Recommendation includes:

– typical application scenarios;

– service requirements;

– management requirements;

– security considerations.

2 References

The following ITU-T Recommendations and other references contain provisions, which through reference in this text constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

None.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 context [b-ITU-T Y.2002]: The information that can be used to characterize the environment of a user.

NOTE – Context information may include where the user is, what resources (devices, access points, noise level, bandwidth, etc.,) are near the user, at what time the user is moving, the interaction history between person and objects, etc. According to specific applications, context information can be updated.

3.1.2 device [b-ITU-T Y.4000]: With regard to the Internet of things, this is a piece of equipment with the mandatory capabilities of communication and the optional capabilities of sensing, actuation, date capture, data storage and data processing.

3.1.3 machine learning (ML) [b-ITU-T Y.3172]: Processes that enable computational systems to understand data and gain knowledge from it without necessarily being explicitly programmed.

3.1.4 machine learning model [b-ITU-T Y.3172]: Model created by applying machine learning techniques to data to learn from.

NOTE 1 – A machine learning model is used to generate predictions (e.g., regression, classification, clustering) on new (untrained) data.

NOTE 2 – A machine learning model may be encapsulated in a deployable fashion in the form of a software (e.g., virtual machine, container) or the hardware component (e.g., IoT device).

NOTE 3 – Machine learning techniques include learning algorithms (e.g., learning the function that maps input data attributes to output data).

3.1.5 machine learning database [b-ITU-T Y.3174]: A component which stores data related to machine learning in the machine learning overlay.

3.1.6 speech to text [b-ITU-T H.862.3]: The process of converting speech input into digital text.

3.1.7 text to speech [b-ITU-T H.862.3]: The process of converting digital text input into speech.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 smart class system (SCS): A system including hardware and software that is used to: aid instruction; manage hardware, software and data resources of teaching and learning devices; and analyse teaching effectiveness.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AI	Artificial Intelligence
AR	Augmented Reality
IMT-2020	International Mobile Telecommunications-2020
IoT	Internet of Things
ML	Machine Learning
MR	Mixed Reality
SCS	Smart Class System
STT	Speech to Text
TTS	Text to Speech
TV	Television
VR	Virtual Reality

5 Conventions

The following conventions are used in this Recommendation:

– The phrase "**is required to**" indicates a requirement that must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

– The phrase "**is recommended to**" indicates a requirement that is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

– The phrase "**can optionally**" indicates a requirement that is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator or service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

6 Overview of smart class systems based on artificial intelligence

With the application of multimedia and information and communication technologies to traditional methods, the effect and quality of teaching has been improved, but it still faces some problems.

– Existing methods for checking attendance are difficult to meet the actual needs of its management, while occupying class time and affecting teaching efficiency. There is a need for high accuracy and efficient methods for checking attendance to assist class management.

– Low efficiency of teacher lecture preparations. In the traditional way, teachers and students do not interact. Teachers prepare lectures according to syllabus, and students follow textbooks before class. This leads to teachers not being able to know whether students have prepared well. It is also difficult for teachers to gain insight into the weaknesses of student preparations and to carry out targeted educational activities.
– Cramming method of teaching. In the traditional teaching model, knowledge is taught by teachers through blackboards or multimedia devices and students listen passively during class.
– Low efficiency of absorption. The information that is shared by teachers through blackboards or multimedia devices is passively received by students during the class. There is a lack of interaction between teachers and students. This force-feeding method cannot stimulate student initiative and creativity.
– Inefficient analysis of teaching effectiveness. Teachers cannot know what students have captured and retained after class immediately. It is also difficult for teachers to check the study progress of each student in real time.
– Outdated teaching equipment. Auxiliary teaching equipment plays an important role in class. As time goes by, much teaching equipment cannot keep up with the changing needs of AI.

Therefore, there are still many educational activities that need to be improved. In the era of AI, its integration, along with big data technology, into education has been strengthened. AI, which is at the cutting edge of innovation, is considered as an effective way to help human solve problems. By utilizing advanced teaching equipment, and collecting, and analysing educational data, AI can assist teachers or students in enhancing lecture preparation, as well as improving both methods and effectiveness of teaching at each stage of the class.

SCS is designed to improve lecture preparation, enhance interaction between teachers and students and promote teaching quality. Based on AI technology, SCS is an efficient way to reduce the teaching workload, provide a vivid learning environment, develop teaching abilities and performance of teachers and cultivate individual learning styles of students.

SCS is an intelligent system based on AI, big data, cloud computing, Internet of things (IoT) and other intelligent information technologies and helps construct an intelligent teaching and learning service environment, providing resource services, interactive services and teaching tools.

7 Typical application scenarios of smart class systems

SCS promotes the transformation from learning knowledge to generating wisdom by creating a student-centred intelligent learning environment and developing intelligent teaching applications. Firstly, based on the intelligent environment, the intelligent application endows the teaching and learning data with educational significance and becomes valuable teaching and learning information through the collection, aggregation, mining and analysis of teaching and learning data. Through collaborative cognition and processing, the information about teaching and learning is transformed into teaching and learning knowledge. Teaching and learning knowledge can then be flexibly applied in teaching and learning activities, and gradually improve the teaching quality of teachers and the learning quality of students. Finally, promote the development of smart classes dominated by data intelligence and AI.

SCS introduces technology into classes, turns the traditional class into one that is information based, interactive, and meets the students' interest points and personality needs. SCS starts from smart learning and smart teaching at the same time to achieve pre-class preparation, in-class learning and after-class consolidation and promotion. The application scenarios of teaching and learning processes based on SCS can be found in Figure 7-1.

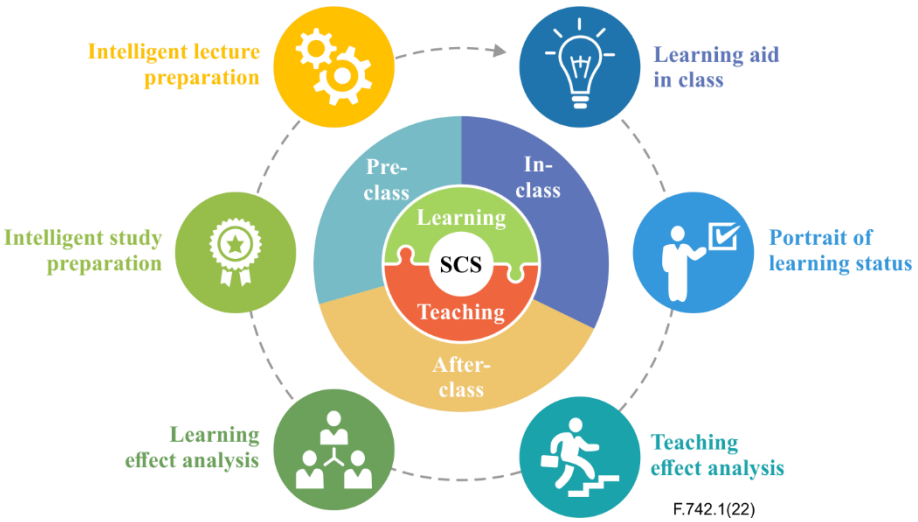

Figure 7-1 – Application scenarios of teaching and learning process based on smart class systems

7.1 Intelligent study preparation pre-class

SCS provides some contents and tasks that students can learn independently before class and push the resource to students to provide them with space for independent thinking. For example, providing attractive resources, videos and pictures for study courses can stimulate student interest in learning. At the same time, SCS can send pre-class questions to students, and the system will automatically generate data analysis reports based on student learning status. SCS can accurately analyse student learning and recommend relevant consolidation exercises to students based on analysis results, thereby developing teaching strategies.

7.2 Intelligent lecture preparation pre-class

SCS intelligently analyses the feedback of student preparation for class and help teachers identify the weaknesses within it, so that teachers can organize teaching centred on student learning. SCS can use the knowledge map to assist teachers to complete the preparation. The system can recommend the same type of information, such as the lesson plan, course explanation and homework, to improve the teaching efficiency of the teacher. The map-based search can also return the desired content more accurately.

7.3 Learning aid during the class stage

With the help of SCS, teachers can present vivid and attractive cartoons of knowledge, e.g., physics experiment, chemical change, biological growth. Students can also use optical character recognition technology to extract text information. Furthermore, these text materials are collated into electronic notes by mobile phone or other intelligent terminal devices.

Based on network communication devices, holographic projection technology, as well as light and sound technology, SCS combines real scenes and virtual backgrounds for teaching. An SCS can provide real-time display, lossless transmission of teaching processes, and enable interaction between teachers and students on the same screen when they are in different places.

SCS can help achieve management of teaching resources. When students or teachers are limited by location or time, teachers and students can watch and discuss the courses through SCS.

7.4 Portrait of learning status in class

SCS can analyse individual differences among students, e.g., their ability and style of learning, and help improve their abilities depending on student gender, age, grade, habits, etc., and design

personalized learning methods to improve their ability. SCS can also predict student' performance through historical learning data.

7.5 Teaching effect analysis after class

After class, teachers can release questions about the class through SCS and guide students to participate in answering questions. Based on this, SCS can help teachers analyse which parts of knowledge are not fully understood by students, evaluate teacher teaching ability, and provide reasonable teaching suggestions.

At the same time, SCS can help teachers analyse the teaching process, take student achievements as labels, analyse the correlation between different teaching methods and knowledge mastery, and recommend different teaching methods to teachers according to different knowledge point.

7.6 Learning effect analysis after class

After class, SCS carries out tests to: analyse which parts of knowledge are not fully understood by students; automatically sorts out and summarize the questions on which students make mistakes; and evaluates the learning effect on students. At the same time, with the information collected in class, SCS can evaluate student learning status and help students know their learning level and whether the learning strategies are useful. Based on student historical learning data to generate student portraits, SCS can analyse their levels from qualitative and quantitative perspectives (such as different subjects, different difficulties), and thus propose different reviews, a preview plan, learning suggestions and even occupation planning.

8 Service requirements of smart class systems based on artificial intelligence

SCS helps change educational concepts of teachers, reconstructs learning processes of students in and out of class, and promotes student active and personalized learning under the guidance of teachers. Through a new generation of information technology, such as big data and AI, SCS achieves intelligent correction of the results of the work. SCS can run alongside teaching, analyse dynamically and evaluate data diagnostically in the learning process, to form a precise learning analysis report to help teachers understand the learning situation of students or their class. From the perspective of the technical level, SCS includes six major modules: class interaction; objective analysis; intelligent push of course resources; display of teaching and learning results; resource generation; and auxiliary tools. Each module and main technologies are shown in Figure 8-1. This clause provides the general requirements and recommendations for SCS service.

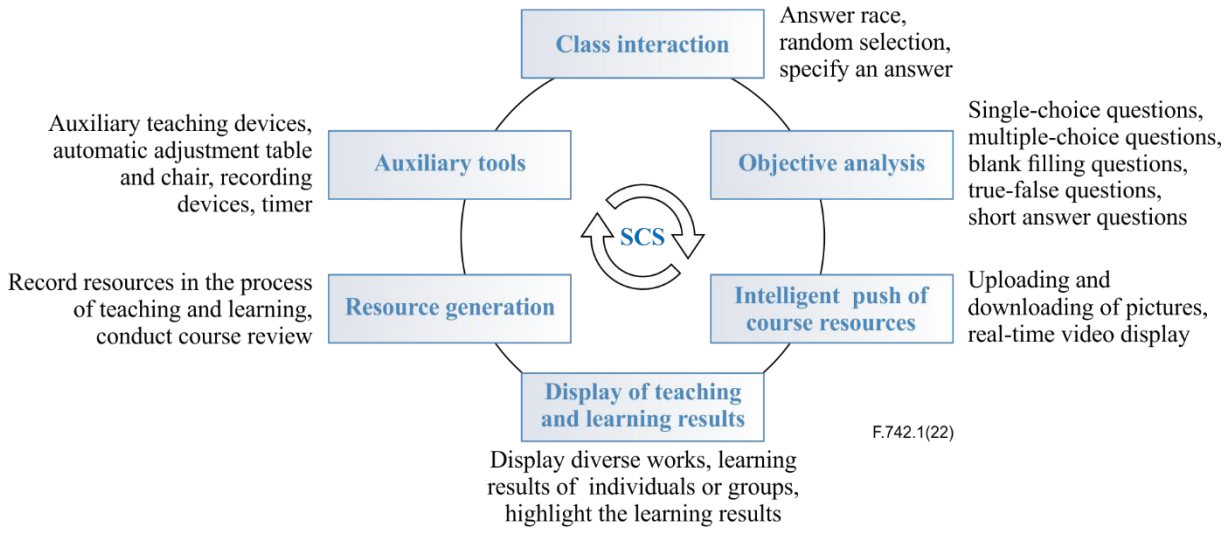

Figure 8-1 – Main technical modules of smart class systems

8.1 Requirements for class interaction

Participation in a class aims to build a harmonious and democratic atmosphere through the interaction of teachers, students and teaching equipment, so that all levels of learners in the classroom can be actively involved in curriculum-related learning events. The requirements and recommendations for class interaction are as follows.

– SCS is recommended to support multiple ways of class interaction through different question-answer strategies. Based on the teaching situation, teachers can adopt an appropriate classroom interactive strategy to effectively regulate student participation in the class.

– SCS is recommended for the recognition of blackboard writing by teachers and student handwriting, and suggestions for learning or teaching.

– SCS is recommended to support interaction through a variety of terminal devices such as: personal computers; pads; mobile phones; television (TV); virtual reality (VR) augmented reality (AR) or mixed reality (MR) equipment; and holographic equipment.

– SCS is recommended to provide real time, reliable and user-friendly speech-to-text (STT) and text-to-speech (TTS) services by utilizing natural language processing. STT and TTS help communication between students and teachers.

– STT and TTS are recommended to be editable and automatic error correction.

8.2 Requirements for objective analysis

The purpose of objective analysis is to examine student mastery of knowledge and understand the teaching situation of teachers. The requirements and recommendations for objective analysis are as follows.

– SCS is recommended to support the analysis of student preparation for class, identify student weaknesses in knowledge (misunderstanding, beyond comprehension, etc.,) and provide teachers with reasonable lecture preparation suggestions.

– SCS is recommended to design single- and multiple-choice questions to help teachers examine student mastery of the class.

– By analysing the knowledge contained in each option, SCS is recommended to assist teachers to understand the learning situation of students, and provide support for effectively promoting the cooperation of learning groups.

– Through the overall answer, SCS is recommended to help teachers determine student completion of the corresponding problems (such as how many students are participating in learning) and mastery of the course (such as the learning effectiveness of the students).

– SCS can optionally provide questions of the "fill in the blank", true-false and short answer types. For these kinds of questions, SCS can optionally handle student feedback in vocal form, pictures and text, and SCS can optionally provide teachers with an evaluation of student answers.

– SCS is recommended to grade examination papers and work results, analyse results after class and form a precise learning analysis report to help teachers understand the learning situation of students or class.

– SCS is recommended to automatically identify and summarize the questions where students make mistakes.

– SCS is recommended to utilize an AI algorithm to help students set an individual learning plan or training performance model to predict their future learning situation based on fundamental data, learning data and other characteristic dimensions.

– SCS is recommended to support the analysis of teacher preparation for class, identify weaknesses in teaching and provide reasonable teaching materials, as well as lecture preparation suggestions.

8.3 Requirements for intelligent push of course resources

SCS assists teachers and students to pass on course resources intelligently. It mainly includes intelligent push methods such as uploading and downloading of pictures, as well as real-time video display. The requirements and recommendations for intelligent push of course resources are as follows.

– SCS is recommended to recognize educational materials, evaluating their level and recommend them to appropriate students.

– SCS is recommended to support the following four intelligent course resources push strategies:

  • Teachers and students can send homework or submit works through one click.

  • Generate the teaching and learning resources by taking pictures or recording through the learning terminal.

  • The student learning process or effectiveness are presented through taking pictures, and evidence collection, presentation and discussion of results with typical characteristics.

  • In the process of teaching, teachers can present and share specific teaching sessions or learning results through videos.

– SCS is recommended to build a personalized knowledge map based on the actual situation of each student, and rely on the construction of the knowledge map to push personalized exercise questions for each student, reduce the time spent on repetitive and invalid questions, and improve learning efficiency.

– SCS is recommended to support the search function by entering audio, image, video or text of educational materials and specific text, image or video is returned.

8.4 Requirements for display of teaching and learning results

SCS displays diverse works showing the results of student lessons or discussions. SCS helps teachers to comprehensively and quickly understand in a timely fashion the learning process, knowledge internalization and learning results of all students, and provide data support to optimize and adjust teaching strategies.

The requirements and recommendations for display of teaching and learning results are as follows.

– SCS is recommended to analyse the learning results of individuals or groups, including the display of different types of results to expand student thinking. By selecting representative student work, the advantages and deficiencies of SCS can be analysed to promote teaching and learning.

– SCS is recommended to highlight learning results according to level. SCS is recommended to support the following three highlight strategies.

  • Highlight excellent results pre-set by teachers, make full use of their demonstration role, and let students understand the typical characteristics of such achievements.

  • Highlight creative and characteristic achievements and guide students to expand their thinking.

  • Pay attention to imperfect results, and analyse the reasons for work that is not well completed, to help students to cover learning gaps in a better way.

8.5 Requirements for resource generation

SCS generates teaching resources through one click. It can automatically record resources in the process of teaching and learning in the form of pictures, PDF manuscripts or videos (mainly graphic materials or operation videos displayed on a teacher's screen). SCS is recommended to realize the following three purposes through resource generation:

- help students conduct course review after class;
- enable students to use resources for personalized tutoring;
- assist teachers to build a teaching process library, and provide effective materials for the construction of education and teaching resources.

The requirements and recommendations for resource generation are given in clauses 8.5.1 to 8.5.4.

8.5.1 Requirements for data preparation

The requirements and recommendations for data preparation are as follows:

– SCS is recommended to provide electronic textbooks and materials such as audio, image, video and text;

– SCS can optionally provide teaching materials such as: VR, AR or MR content; holographic content; flash animation; stickers; music and sound;

– SCS can optionally provide curriculum information and scheduling, as well as student and teacher attendance information;

– SCS can optionally provide recording information of teacher lectures, blackboard writing and multimedia teaching;

– SCS can optionally provide live broadcast and on-demand lecture resources;

– SCS can optionally provide the knowledge map of data on student learning, teacher teaching and curriculum;

– SCS is recommended to provide storage space for building machine-learning (ML) databases to store data including audio, images, video, text and knowledge maps.

NOTE 1 – Educational materials can be uploaded and downloaded through different protocols.

NOTE 2 – The SCS data can be opened and shared to ML services and can be accessed only in the SCS. Specification of mechanisms for SCS data openness lie outside the scope of this Recommendation.

8.5.2 Requirements for data pre-processing

The requirements and recommendations for data pre-processing are as follows:

– SCS is recommended to support the intelligent collection of curriculum resource data in multiple scenarios and multiple teaching modes;

– SCS is required to support the pre-processing of education materials, such as separating teaching video into frames and extracting key frames;

– SCS is required to support the recognition and classification of educational videos;

– SCS is recommended to support multi-dimensional analysis of educational video, including subjects, scenes, objects, labels, voices, text and faces;

– SCS is recommended to support statistical functions and provide visualized control systems, which can present class conditions through dynamic statistics.

8.5.3 Requirements for model training and deployment

The requirements and recommendations for model training and deployment are as follows:

– SCS is recommended to support the training of ML models based on an educational ML database;

– SCS is recommended to support the indication of ML model-training status;

– SCS is recommended to support the deployment and inference of ML model.

8.5.4 Requirements for data security

The requirements and recommendations for data security are as follows:

– SCS is required to provide a security and personally identifiable information protection mechanism on collected data;
– SCS is required to authorize and authenticate access to class data;
– SCS is required to authorize and authenticate when training and deploying AI capabilities.

8.6 Requirements for auxiliary tools

The requirements and recommendations for auxiliary tools are given in clauses 8.6.1 to 8.6.5.

8.6.1 Requirements for course auxiliary devices

– SCS is recommended to provide course auxiliary devices for teaching and learning, such as an intelligent timer, intelligent screen and intelligent dictionary pen. The auxiliary devices provide teachers and students with assistance for teaching and learning.
– Course auxiliary devices of SCS can optionally provide teachers and students with VR, AR or MR and holographic interactive services.

8.6.2 Requirements for recording devices

– SCS lecture-recording devices (voice recorder, camera, etc.) can optionally acquire data from teacher and student blackboard writing, voices and videos on the premise of ensuring data security.

8.6.3 Requirements for smart tables and chairs

– SCS is recommended to provide tables and chairs that are flexible to move and can automatically adjust height and tilt angle according to student's height, body mass or sitting position.

8.6.4 Requirements for classroom environment

– SCS is recommended to automatically adjust temperature, humidity, brightness and other classroom conditions to enhance learning and teaching effects.

8.6.5 Requirements for compatibility

– SCS is required to support the access by various terminal hardware devices, e.g., a PC; pad; mobile phone; TV; VR, AR or MR equipment and holographic equipment.
– SCS is recommended to support various operating system platforms.
– SCS is recommended to be compatible with various browsers.

9 Management requirements of smart class systems based on artificial intelligence

– SCS is recommended to check attendance through face recognition technology, and complete statistics of student attendance results before teaching starts.
– SCS is recommended to support enquiry into attendance data of students and courses.
– SCS is recommended to support multi-dimensional data analysis based on departmental or class attendance data.
– SCS is required to support the management of basic information about teachers and students, including its creation, deletion, modification, searching and browsing, and specify the operation permissions for this function.
– SCS is required to analyse and display education management information, such as the number of teachers and students, and shows the current teaching progress.
– SCS is recommended to intelligently generate management suggestions or guidance for education management.

10 Security considerations

This Recommendation describes requirements for SCSs based on AI supported by IMT-2020 and beyond; therefore, general security requirements and mechanisms specified for Internet protocol-based networks and a high-level architecture framework for ML should be applied, see [b-ITU-T Y.3101] and [b-ITU-T Y.3172]. The security mechanisms such as authentication, authority, accounting and encryption should be adopted to ensure SCS security.

Appendix I

A reference architecture for smart class systems

(This appendix does not form an integral part of this Recommendation.)

SCS is an intelligent system based on AI, big data, cloud computing, IoT and other intelligent information technologies. It is mainly composed of smart cloud service, a smart platform, smart teaching, learning and management terminal and smart environment terminal. A reference architecture for SCS is depicted in Figure I.1.

– Smart cloud services provide resource management, micro-course management, open courses, online teaching and learning, and online research, etc., based on cloud service.

– The smart platform is equipped with intelligent centres for classroom communication, data, control and competence.

– Smart terminals include intelligent teaching, learning and management terminals, such as the teacher's intelligent terminal, the students' intelligent terminal, intelligent management terminals and the parents' intelligent terminal.

– Smart environment terminals mainly include intelligent hardware facilities and intelligent software equipment. SCS constructs an intelligent teaching and learning service environment, providing resource services, interactive services and teaching tools.

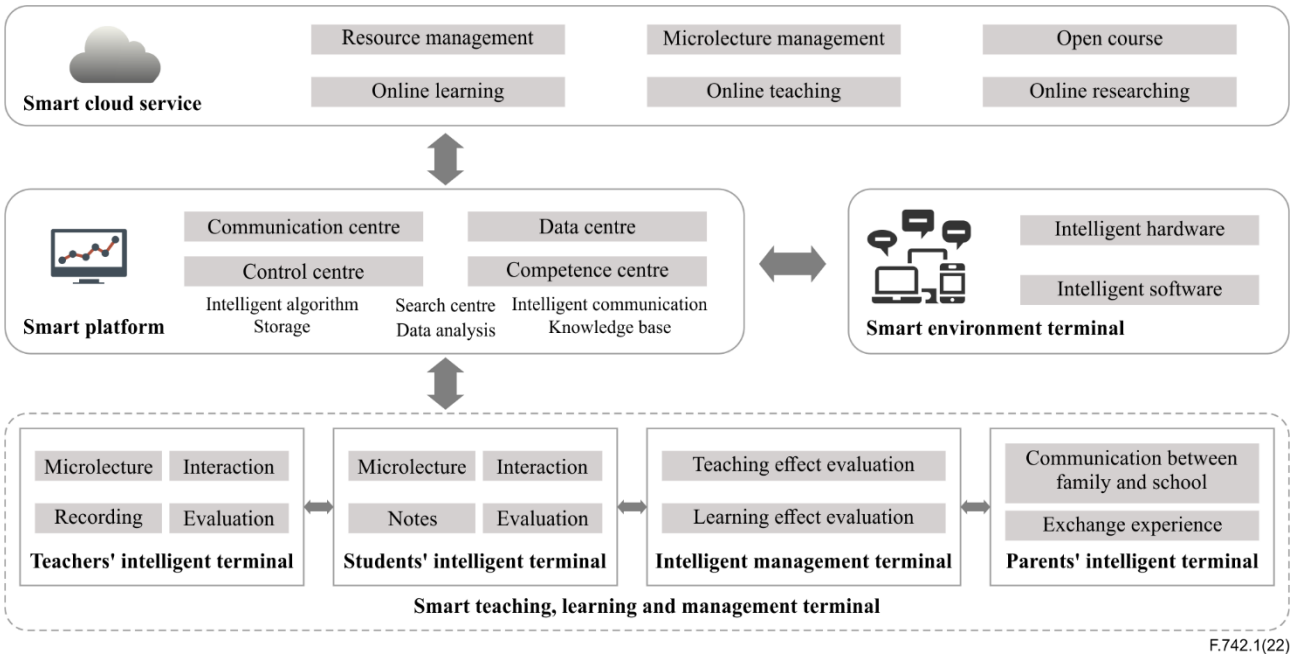

Figure I.1 – Reference architecture for smart class systems

SCS is designed to improve lecture preparation, enhance interaction between teachers and students and promote teaching quality. Based on AI technology, SCS is an efficient way to reduce the teaching workload, provide a vivid learning environment, develop teaching abilities and performance, and cultivate individual learning styles of students.

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