國立中正大學通識教育課程教學大綱

National Chung Cheng University Course Syllabus of General Education

開課學年度/學期 School Year/ Semester	114 學年度第 1 學期		
課程名稱 (中文) Course Title (CH)	探索科學圖像		
課程名稱 (英文) Course Title (EN)	Exploring scientific images		
課　　碼 Course ID		學分數 Credit	2
授 課 方 式 Instructional Methods	請勾選(可複選) (Multiple Selection)： ■課堂講授 Lecturing　□網路教學 Distant Learning　■分組討論 Group Discussion □校外教學 Fieldtrip　■其他 小組專案 Others Group engagement project		
教學目標及範圍 Course Objectives	● **By taking this course, students are expected to be able to:** 1. understand and use the key concept: representation 2. understand how visual representation relates to knowledge in historical and philosophical aspects 3. gain a basic idea about epistemology and be able to apply it in case studies 4. build transferable skills for critical thinking, team coordination, and professional communication ● **教學目標** 1. 對「視覺化表徵」此一概念有基本的瞭解 2. 認識到科學圖像的歷史與當代的科學圖像有何關係 3. 能運用課程所授的哲學概念去思考及分析科學圖像 4. 獲得批判思考、團隊協調及專業發表等等可轉移的技能 ● **Course Description** This course introduces the philosophical concept of representation and focuses on visual representations in science. It takes an epistemological approach to the roles of		

visual representations in the formation of scientific knowledge. Visual representations are important vehicles for scientific observation, reasoning, instruction, and communication. This course starts by introducing the core concept of the semester, namely representation. An overview of philosophical discussions of the relationship between representation and the epistemology of science follows the introduction. Then, the course guides the students through a series of historical and contemporary cases on the intertwinement of representing practices and knowledge production, showing how the values and virtues of scientific knowledge production are embedded in representations. In addition to delivering philosophical concepts, this course provides the students with training in both academic and transferable skills. The former includes academic discussion, research ethics, and academic writing. The latter includes critical thinking, teamwork, and professional communication skills. The students are expected to participate in discussions and in-class exercises actively.

- **教學範圍概述**

科學圖像為近年新興且迅速發展之科學史與科學哲學領域，既有文獻已揭示科學圖像所表徵之豐富意義，例如科學研究的本質與追求、科學推理的過程、科學成果的形式與影響等等，這其實反映了一個情況，那就是圖像（或視覺化資料）常是不限於科學之廣義文化的重要表徵資源。本課程的核心概念便是「表徵」，並將科學圖像視為科學中的視覺化表徵，從文藝復興時期至當代的歷史中擇取兼具趣味性與深遠意義的主題，讓學生認識如何以表徵的相關概念去探究科學圖像所包含的上述豐富資訊，引導學生進一步分析圖像與科學事物之間的表徵關係是如何形成。課程高度要求學生進行跨領域之批判性思考，並與自身的專業訓練對照。

授課大綱
(週次表及每週課程詳細內容說明)
Schedule

週次 Week	主題 Topics
1	Introduction
2	Core concept of the semester: representation (1)
3	Core concept of the semester: representation (2)
4	Renaissance anatomical illustrations (1)
5	Renaissance anatomical illustrations (2)
6	Icons, indices, symbols
7	Geological diagrams as an expert language (1)
8	Geological diagrams as an expert language (2)
9	Midterm project presentation
10	From "truth-to-nature" to "trained judgment" (1)
11	From "truth-to-nature" to "trained judgment" (2)
12	Darwin's "fake" images?!
13	From "truth-to-nature" to "trained judgment" (3)
14	New sight: microscopic images and beyond
15	Representation, presentation and persuasion (1)
16	Representation, presentation and persuasion (2)
17	Final project tutorial
18	Final project presentation

每週課程詳細內容說明 Detailed lesson plan：

週次 Week	Topic & Detail	中文說明
1	Introduction Course induction and introduction: the former walks students through the course scope and the guidelines for assignments, assessments, and projects. The latter includes a preview of the key ideas of the semester and a pilot survey on students' views of scientific images.	說明課程結構、評分機制、課程宗旨與範圍，前測學生對科學圖像的認識、印象與感受。
2	Core concept of the semester: representation (1)	講授「表徵」以及「視覺化表徵」這兩個哲學概

			Introduces the concepts of “representation” and “visual representation” by naming concrete examples across disciplines and sectors.	念，不限於科學中的表徵，而是包含日常生活與媒體內容等等科學研究以外的範疇，說明我們為何可以將圖像視為視覺化表徵，先從廣義的綜論開始，以實際例子說明。 閱讀文本：教師編纂之課程講義，另參考 Hentschel, Klaus. *Visual cultures in science and technology: a comparative history*.	
		3	Core concept of the semester: representation (2) Introduces the philosophical scholarship on representation and visual representation, as well as how these concepts are associated with the epistemology of science, i.e. the study of a range of things related to scientific knowledge.	講授「科學中的表徵」之科學哲學概念，帶領學生進行指定讀物之討論。 閱讀文本：Frigg, Roman, and James Nguyen. “Scientific Representation”.	
		4	Renaissance anatomical illustrations (1) Introduces the revolutionary changes brought about by the Renaissance anatomical practice and the impacts of its legacy on modern anatomy.	介紹文藝復興時期解剖學教學研究實作經歷過怎樣一場革命性的改變，這段歷史如何體現在解剖學圖譜的樣貌。 閱讀文本：教師編纂之課程講義、Vesalius. *The Fabric of the Human Body*（網路開放全文之歷史文本）、並參考 Butterfield, H. "Renaissance Art and Modern Science".	

		5	Renaissance anatomical illustrations (2) • Introduces the intertwinement of anatomical and representing practices in the Renaissance time. • Inspires students to reflect on the similar relationship between anatomical and representing practices in contemporary medicine and life sciences.	經由介紹文藝復興時期解剖學實作與圖像生產實作的交織，引導學生思考現代醫學研究中的視覺化表徵之哲學啟示。 閱讀文本：Vesalius. *The Fabric of the Human Body*（網路開放全文之歷史文本）	
		6	Icons, indices, symbols Introduces the philosophical concepts of signs (as established by semiotics), providing a widely applicable conceptual framework for analyzing visual representations across scientific and non-scientific fields.	用日常生活例子講授基礎的符號學理論，讓學生習得可用於解析視覺化表徵的概念框架，並帶領學生進行指定讀物之討論。 閱讀文本：教師編纂之課程講義、Atkin, Albert. “Peirce's Theory of Signs”.	
		7	Geological diagrams as an expert language (1) Introduces the pre-modern to modern history of the development of geological images, demonstrating how these visual representations reflected the interplay among the multiple origins of modern	介紹十八世紀末至十九世紀初的地質學圖像之樣貌是如何與地質學、自然史的研究法交織演變。	

			geology.		
		8	Geological diagrams as an expert language (2) Following up on the previous introduction of the epistemological reflection of images, this topic explains why scientific images are considered by many as visual languages of expert communities. This view has a lot to do with the interplay between the development of visual language and the formation of expert communities.	從地質學研究法與地質學圖像生產的交織，引出科學視覺化表徵為什麼可以被視為一種專家社群的語言，以及這種「視覺語言」與專家社群的形成有什麼樣的關係，並帶領學生進行指定讀物之討論。 閱讀文本：Rudwick, Martin J. S. "The Emergence of a Visual Language for Geological Science 1760-1840".	
		9	Midterm project presentation Along with group project presentations and the instructor’s feedback, student-initiated noncompetitive discussions, Q/A, and debates are strongly encouraged.	期中報告展示，要求學生各組之間在沒有競爭關係的前提下踴躍問答、辯論、互動，教師當場給予講評。	
		10	From "truth-to-nature" to "trained judgment" (1) Recaps the relationship between visual representation and the epistemology of science on the ground that a series of historical cases have previously demonstrated such a relationship. From this week, students are required to read and discuss the core reading of the semester under	講授科學視覺化表徵與科學認識論之關係的科學哲學概念，介紹十八世紀「忠於自然」之典範下科學與藝術的關係，並帶領學生進行指定讀物之討論。 閱讀文本：教師編纂之課程講義、Galison, Peter. “Judgment against Objectivity”.［按：該篇為本課程極重要讀物，且有	

			supervision. This reading seminar series starts with the history of science-art collaborations in the “truth-to-nature” tradition of the 18th century.	深度閱讀前所需跨越之理論門檻，將搭配講義、分段導讀，故在課綱中列出數次。］
		11	From "truth-to-nature" to "trained judgment" (2) The core reading seminar goes on to introduce the 19th-century scientific ideal, “mechanical objectivity”, and the related (yet not necessarily consequential) separation of science and art. Students are encouraged to reflect on the influences of such an ideal on modern scientific practice and the contemporary science-art relationship (as they perceive it).	繼續講授科學視覺化表徵與科學認識論之關係的科學哲學概念，介紹十九世紀「機械客觀性」典範下科學圖像與藝術圖像的分道揚鑣，啟發學生思考當代的科學與藝術關係，並帶領學生進行指定讀物之討論。 閱讀文本：Galison, Peter. “Judgment against Objectivity”.
		12	Darwin’s "fake" images?! This topic furthers the discussion of the interplay between knowledge production and visual representation by introducing a fascinatingly interesting historical case, a volume on the study of animal expressions written by Charles Darwin.	以極富趣味的例子、亦即達爾文對動物表情學的研究，介紹現代科學發展之初，圖像與研究法的相互關係，並帶領學生進行指定讀物之討論。 閱讀文本：Darwin, C. R. *The expression of the emotions in man and animals*.
		13	From "truth-to-nature" to "trained judgment" (3) The core reading seminar goes	繼續講授科學視覺化表徵與科學認識論之關係的科學哲學概念，介紹二十世

			on to introduce the 20th-century standard for scientific visual representation, “trained judgment”, and how the emergence of this new standard reflected the historical changes in scientists’ self-identity and self-image.	紀至今「專家判斷」在科學圖像之生產與詮釋中的功能，啟發學生思考「機械客觀性」與「專家判斷」兩種典範在當代科學圖像中的體現，並帶領學生進行指定讀物之討論。 閱讀文本：教師編纂之課程講義、Galison, Peter. “Judgment against Objectivity”.	
		14	The mind’s eye Introduces the close relationship between visualization and the hands-on tradition of technology and engineering, revealing the epistemological and methodological roles of visualization in these fields. Students should be inspired to reflect on both relevant everyday examples and their experiences in disciplinary training.	講授機械、技術與工程領域中圖像的認識論與方法論功能，啟發學生思考日常生活中類似的、視覺化表徵與「動手做」之密切關係的例子，例如家具組裝。 閱讀文本：Ferguson, Eugene S. "The mind's eye: Nonverbal thought in technology".	
		15	Representation, presentation, and persuasion (1) Introduces the philosophical relationship between originality, persuasion, and the implication of removing the prefix “re-” from the term “representation”.	講授當代科學圖像為何可以被認為是從「再現式」表徵（representation）到原創呈現（presentation）的演變，並帶領學生進行指定讀物之討論。 閱讀文本：教師編纂之課程講義（並參考 Wood, D. *The Power of Maps.*）、Daston, Lorraine,	

				and Peter Galison. *Objectivity.* (選讀)、Chao, Hsiang-Ke, and Harro Maas. “Thinking and Acting with Diagrams”.	
		16	Representation, presentation, and persuasion (2) Following the first half of the topic, the second half uses concrete examples chosen from protein structure study, nano-material simulation, and anatomy to support the philosophical discussion.	用蛋白質結構模擬、奈米材料模擬等例子，繼續介紹當代某些領域科學圖像的「原創呈現」性質，並解答：這一性質為何與「說服」有關？是要說服什麼對象？說服的目的是什麼？這與現代科學技術的特質有什麼關係？ 閱讀文本：教師編纂之課程講義、Daston, Lorraine, and Peter Galison. *Objectivity.*、另參考 Gooding, David. *Experiment and the making of meaning: human agency in scientific observation and experiment*.）	
		17	Final project tutorial The tutorial consults students’ final project bibliographies (which must be submitted within the required time frame prior to the week), responds to students’ inquiries about project development, and provides an introduction to professional presentation and academic ethics.	期末報告輔導，就學生預先繳交之參考書目進行諮詢，並講授基本的專業簡報技巧及學術倫理。	
		18	Final project presentation	期末報告展示，要求學生	

			Along with group project presentations and the instructor's feedback, student-initiated noncompetitive discussions, Q/A, and debates are strongly encouraged.	各組之間在沒有競爭關係的前提下踴躍問答、辯論、互動，教師當場給予講評。

教科書及 延伸閱讀 Course Materials and Additional Resources	**指定閱讀** • 教師編纂之課程講義 • Ferguson, Eugene S. 1977. "The mind's eye: Nonverbal thought in technology." *Science* 197 (4306):827-836. • Frigg, Roman, and James Nguyen. 2020. Scientific Representation. In *The Stanford Encyclopedia of Philosophy (Spring 2020 Edition)*, ed. Edward N. Zalta. https://plato.stanford.edu/archives/spr2020/entries/scientific-representation/ • Galison, Peter. 1998. Judgment against Objectivity. In *Picturing Science, Producing Art*, eds. Peter Galison, and Caroline A. Jones. London: Routledge. • Darwin, C. R. 1872. *The expression of the emotions in man and animals*. 1st edition Aufl. London: John Murray. **參考書目** • Atkin, Albert. 2013. Peirce's Theory of Signs. In *The Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta. • Butterfield, H. 1964. "Renaissance Art and Modern Science." In *Origins of the Scientific Revolution*, edited by Hugh Kearney. London: Longmans. • Bechtel, William, Danial Burnston, Benjamin Sheredos, and Adele Abrahamsen. 2014. "Representing Time in Scientific Diagrams." Proceedings of the 36th Annual meeting of the Cognitive Science Society, Quebec City, Canada. • Carusi, Annamaria. 2008. Scientific visualisations and aesthetic grounds for trust. *Ethics and Information Technology* 10:243-254. doi:10.1007/s10676-008-9159-5. • Chao, Hsiang-Ke, and Harro Maas. 2020. Thinking and Acting with Diagrams. *East Asian Science, Technology and Society: An International Journal* 14 (2):191-197. doi:10.1215/18752160-8537965. • Coopmans, Catelijne, Janet Vertesi, Michael E. Lynch, and Steve Woolgar. 2014. *Representation in Scientific Practice Revisited*. Cambridge: The MIT Press.

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Daston, Lorraine, and Peter Galison. 2007. Objectivity. Cambridge:Routledge.
Ekman, Paul. 2003. "Darwin, Deception, and Facial Expression." Annals of the New York Academy of Sciences 1000 (1):205-221.
Gooding, David. 1990. Experiment and the making of meaning: human agency in scientific observation and experiment. Boston: Kluwer Academic Publishers.
Hentschel, Klaus. 2014. Visual cultures in science and technology: a comparative history. Oxford: Oxford University Press.
Jones, Peter Galison, and Caroline A. Jones. 2014. Picturing Science, Producing Art. London: Routledge.
Lynch, Michael. 1990. The externalized retina: Selection and mathematization in the visual documentation of objects in the life sciences. In Representation in Scientific Practice, eds. Michael Lynch, and Steve Woolgar. London: The MIT Press.
Lynch, Michael, and Steve Woolgar. 1990. Representation in Scientific Practice. Cambridge, MA: The MIT Press.
Pauwels, Luc. 2006. Visual culture of science. London: Dartmouth College Press.
Rudwick, Martin J. S.. 1976. "The Emergence of a Visual Language for Geological Science 1760-1840." History of Science 14:149-195.

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<tr><td>評 量 方 式
Grading</td><td>
請勾選(可複選)，並填寫類別(Multiple Selection)：：
■課堂參與__C__類 Participation　□期 中 考____類 Mid-Term Exam　□期 末 考____類 Final Exam　■小組報告__A__類 Group Report
■小組討論__B__類 Group Discussion　□書面報告____類 Written report　■課後作業__B__類 Homework　■平時測驗__B__類 Quiz
□心得分享____類 Reflection　□學習紀錄____類 Learning profile　■專題創作_A_類 Project or Portfolio　□其他_____類 Others
A 類佔_45_%；B 類佔_35_%；C 類佔_20_%；D 類佔___% (類別可自行增加)
Type A _45_%；Type B_35_%；Type C_20_%；Type D__% (Add if needed)

Details：

Course participation includes required reading discussions, case studies, and other in-class discussions. Materials for such in-class activities will be announced beforehand. Students must be aware that an AWOL (absent without leave) results in a 55 on the occasion.
The midterm and final projects are equivalent to midterm and final exams. Legitimate leave from the project presentation day(s) is only approved via the

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official process.

3. Assignments and project documents must be submitted electronically.
4. The course materials (as shared on the NCCU moodle) are only for internal use in this educational context and cannot be circulated or disseminated to any third parties. Commercial use of the course materials is strictly prohibited.

說明：

- 案例分析、必讀讀物討論及隨堂測驗均為計分討論，無故缺課則當次 55 分。
- 期中、期末報告，若有不可抗力之因素導致必須缺席，需依校方規定請假。
- 課程所有作業報告均僅接受電子檔。
- 電子檔教材僅供課堂內部使用，限於此教育環境內合理使用具版權之資料，不可傳播於課程外之對象，更不可用以營利。

與聯合國永續發展目標(SDGs)及細項之對應 (請參閱 SDGs 對照表)

UN SDGs Goals and Targets

目標:4 細項：_4.7__4.a_____

目標:_10_細項：__10.3_____

目標:_17_細項：__17.18_____

核心能力指標設定 Core Ability Goals

通識課程 核心能力指標 (請勾選主要的 3-5 項) Core Abilities of General Education (Select 3-5 main Goals)	說明 Detail	課程能培養學生此項核心能力者請打 Select if Correlated ✓
(1)思考與創新 Thinking and Innovation	能夠進行獨立性、批判性、系統性或整合性等面向的思考，或能以創意的角度來思考新事物。	✓
(2)道德思辨與實踐 Moral Thinking and Application	能夠對於社會、文化中相關的倫理或道德議題，進行明辨、慎思與反省，或能實踐在日常生活中。	✓
(3)生命探索與生涯規劃 Life Exploration and Career	能夠主動探索自我的價值或生命的真諦，或能具體實踐	

	Planning	在自我生涯的規劃或發展。	
	(4)公民素養與社會參與 Citizenship and Community Engagement	能夠尊重民主與法治的精神、關心公共事務及議題，或能參與社會事務及議題的討論與決策。	
	(5)人文關懷與環境保育 Humanity and Environment Protection	能夠具備同理、關懷、尊重、惜福等人文素養，或能擴及到更為廣泛的環境及生態議題。	
	(6)溝通表達與團隊合作 Communication Skills and Teamwork	能夠善用各種不同的表達方式進行有效的人際溝通，或能理解組織運作，與他人完成共同的事物或目標。	✓
	(7)國際視野與多元文化 Global Perspectives and Cultural Differences	能夠了解國際的情勢與脈動，具備廣博的世界觀，或能尊重或包容不同文化間的差異。	
	(8)美感與藝術欣賞 Art Appreciation	能夠領略各種知識、事物或領域中的美感內涵，或能據此促成具美感內涵之實踐力。	
	(9)問題分析與解決 Problem Solving	能夠透過各種不同的方式發現問題，解析問題，或能進一步透過思考以有效解決問題。	✓