國立中正大學通識教育課程教學大綱

開課學年度/學期	114 學年度第 1 學期		
課程名稱 (中文)	探索科學圖像		
課程名稱 (英文)	Exploring scientific images		
課　　碼	(由通識教育中心填寫)	學分數	2
授 課 方 式	請勾選(可複選)： ■課堂講授　□網路教學　■分組討論 □校外教學　■其他 專案報告		
教學目標及範圍	● **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.

- **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

授 課 大 綱 (週次表及每週課程詳細內容說明)

週次	主題
1	Introduction
2	Core concept of semester: representation (1)
3	Core concept of 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 judgement’ (1)
11	From ‘truth-to-nature’ to ‘trained judgement’ (2)
12	Darwin’s ‘fake’ images?!
13	From ‘truth-to-nature’ to ‘trained judgement’ (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：

週次	主題	詳細說明
1	Introduction	Course induction and introduction: the former walks students through the course scope, as well as 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.
2	Core concept of semester: representation (1)	Introduces the concepts of “representation” and “visual representation” by naming concrete

				examples across disciplines and sectors.	
		3	Core concept of 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.	
		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.	
		5	Renaissance anatomical illustrations (2)	• Introduces the intertwinement of anatomical and representing practices in the Renaissance time. • Inspires students to reflect on the relationship between anatomical and representing	

				practices in contemporary medicine and life sciences.	
		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.	
		7	Geological diagrams as an expert language (1)	Introduces the pre-modern and modern developments of geological images, demonstrating how these visual representations reflected the interplay among the multiple origins of modern 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.	
		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.	
		10	From 'truth-to-nature' to 'trained judgement' (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 supervision. This reading seminar series starts with the history of science-art collaborations in the "truth-to-nature" tradition of the 18th century.	
		11	From 'truth-to-nature' to 'trained judgement' (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).	
		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 19C volume on the study of animal expressions written by Charles Darwin.	
		13	From ‘truth-to-nature’ to ‘trained judgement’ (3)	The core reading seminar goes 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.	
		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.	
		15	Representation, presentation and persuasion	• Introduces the philosophical relationship between originality, persuasion, and the implication of removing the prefix "re-" from the term "representation". • Uses concrete examples chosen from protein structure study, nano-	

			material simulation, and anatomy to support the philosophical discussion.
	16	Reading week and final project tutorial (by request)	Reading week and final project tutorial (by request)
	17	Reading week and final project tutorial (by request)	Reading week and final project tutorial (by request)
	18	Final project presentation	Along with group project presentations and the instructor's feedback, student-initiated noncompetitive discussions, Q/A, and debates are strongly encouraged.
教科書及延伸閱讀	**Core and required readings** • Course hangouts (edited by the instructor and for internal use ONLY) • 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.
- (Applicable only if students can read Chinese) 區曦中，2022。〈生物學中的視覺化表徵〉，《華文哲學百科》。

Supplemental readings

- 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.
- 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

<table>
<tr><td></td><td>Geological Science 1760-1840." History of Science 14:149-195.</td></tr>
<tr><td>評 量 方 式</td><td>請勾選(可複選)，並填寫類別：
■課堂參與__C_類 □期 中 考____類 □期 末 考____類 ■小組報告_A_類
■小組討論__B_類 □書面報告____類 ■課後作業_B_類 ■平時測驗_B_類
□心得分享____類 □學習紀錄____類 ■專題創作_A類 □其他_____類
A 類佔__45 %；B 類佔_35_%；C 類佔_20_%；D 類佔____% (類別可自行增加)

<table><tr><td>Assessment</td><td>percentage</td></tr><tr><td>In-class quiz, discussions and case studies</td><td>20</td></tr><tr><td>Midterm project</td><td>35</td></tr><tr><td>Final project</td><td>45</td></tr></table>
Details:
• The course materials are for internal education use only. Copyrighted materials may be used reasonably within this educational environment and must not be disseminated elsewhere. Profitable uses are strictly prohibited.
• Group assignment: required readings or case studies are assigned a week prior to the in-class discussion. In the discussion, students are required to present their findings and respond to follow-up questions from the instructor and their classmates. See course schedule for details.
• Midterm project: case study-based group engagement. By answering the required questions, students are expected to demonstrate their acquired knowledge about the concepts taught, their critical analytical skills, and their abilities to teamwork</td></tr>
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<tr><td></td><td>and communicate professionally.
• Semester project: the same as the midterm project, except that students are further expected to demonstrate their ability to coherently draw on all the ideas taught throughout the semester.
• Case analyses, in-class quizzes, discussions, and required reading discussions are graded. An absence without legitimate leave results in a 55 for the occasion.

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。無故缺席或遲到，依缺席時間所佔該組報告時間比例扣個人報告總分。
• 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。</td></tr>
<tr><td>與聯合國永續發展目標(SDGs)及細項之對應

(請參閱 SDGs 對照表)</td><td>目標:4 細項：_4.7__4.a_____
目標:_10_細項：__10.3_____
目標:_17_細項：__17.18_____
(至多三個目標，每個目標至多三個細項)</td></tr>
<tr><td>核心能力指標設定</td><td><table><tr><td>通識課程</td><td>說明</td><td>課程能培</td></tr></table></td></tr>
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	核心能力指標 (請勾選主要的3-5項)		養學生此項核心能力者請打✓
	(1)思考與創新	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	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	能夠主動探索自我的價值或生命的真諦，或能具體實踐在自我生涯的規劃或發展。	
	(4)公民素養與社會參與	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	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	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	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	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	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。	✓
備　　註			