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An AI-Generated Semantic Communication Platform in Human-Computer Interaction Course

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***Abstract*—**Almost every aspect of our daily lives is now intertwined with some degree of Human-Computer Interaction (HCI). HCI courses draw on knowledge from disciplines as diverse as computer science, psychology, design principles, anthropology and more. The HCI courses in the Department of Electronics at Tsinghua University, known as the Media and Cognition course, is constantly updated to reflect the most advanced technological advances, such as virtual reality, augmented reality and artificial intelligence-based interaction. For more than a decade, this course has used an interest-based approach to teaching, in which students proactively propose some research-based questions and collaborate with teachers, using course knowledge to explore potential solutions. Semantic communication plays a key role in facilitating understanding and interaction between users and computer systems, ultimately enhancing system usability and user experience. The advancements in AI-generated technology, which has gained significant attention from both academia and industry in recent years, are exemplified by language models like GPT-3 that generate human-like dialogues from given prompts. The latest version of the HCI course practices a semantic communication platform based on AI-generated techniques. We explored a student-centered model and proposed an interest-based teaching method. Students are no longer just recipients of knowledge, but become active participants in the learning process driven by personal interests, thereby encouraging students to take responsibility for their own education. One of the latest results of this teaching approach in the course "Media and Cognition" is a student proposal to develop a semantic communication platform rooted in artificial intelligence generative technologies. The platform solves a key challenge in communications technology: the ability to preserve visual signals. The interest-based approach emphasizes personal curiosity and active participation, and the proposal of an artificial intelligence-generated semantic communication platform is an example and successful result of how students can exert greater creativity when they have the power to control their own learning.

***Keywords*—**Human-computer interaction, media and cognition course, semantic communication, retain ability, prompts.

I. Introduction

IN the contemporary epoch of the information society and artificial intelligence (AI), the integration of information science and technology into diverse domains underscores its expansive potential for innovation. This potential is particularly evident at its confluence with fields such as energy, environment, and biomedicine. Within tertiary education institutions, rigorous academic research is intrinsically linked with the nurturing of exceptional student talent. Today, HCI has seamlessly integrated into both our professional and personal realms, becoming a pervasive technology. As an interdisciplinary domain, HCI melds computer science, psychology, fundamental design acumen, anthropology, and various other expansive fields to foster a more intuitive and enriching interaction between humans and computers. The field of electronic information has experienced significant developments over the past few decades.

The HCI-related course offered in our teaching system is "Media and Cognition", which has become an important basic course in our teaching system. Our courses are constantly updated with application-oriented course content and refer to HCI-related courses from famous universities such as MIT and Stanford University [1], [2]. MIT's HCI course delves into design principles, cognitive psychology, and the intricacies of user-centered evaluation. It discusses how to understand and optimize the relationship between humans and their technological environment. Students will learn how to understand users, define problems, conceptualize solutions, prototype and test their efficacy. Stanford's HCI program emphasizes the importance of modern technology disciplines, providing students with the knowledge, tools, and mindset to prioritize human needs in technology design, emphasizing the design thinking process to ensure solutions are successful from inception to implementation.

The traditional classroom model mainly uses the form of teachers disseminating information and students passively absorbing it. However, in our practice of teaching the "Media and Cognition" course, we explored a student-centered model and proposed an interest-based teaching method. Students are no longer just recipients of knowledge, but become active participants in the learning process driven by personal interests, thereby encouraging students to take responsibility for their own education. One of the latest results of this teaching approach in the course "Media and Cognition" is a student proposal to develop a semantic communication platform rooted in artificial intelligence generative technologies. The platform solves a key challenge in communications technology: the ability to preserve visual signals. The interest-based approach emphasizes personal curiosity and active participation, and the proposal of an artificial intelligence-generated semantic communication platform is an example of how students can exert greater creativity when they have the power to control their own learning.

II. Related Work

Reference [3] proposes a course design method based on

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good design and user-centeredness, called the studio method. Students work in groups and engage in collaborative design activities, which are evaluated during weekly critique sessions. Course content includes topics such as requirements specification, preliminary system design, heuristic evaluation, prototype implementation, and usability testing. The studio approach helps students immediately immerse themselves in the design process, learning by creating realistic artifacts rather than passively listening to lectures. Close collaboration between students and teachers enhances learning and weekly lecture themes are observed to be integrated into their design. Student feedback shows positive results from the studio approach and satisfaction with the course. However, students also expressed difficulties with the workload and unfamiliar studio teaching and grading methods. Overall, the studio approach successfully achieved its goal of developing more effective methods of teaching design. They believe this approach will be equally beneficial for a more skilled group of students, allowing them to solve more complex design problems.

In a separate study [4], researchers assessed the efficacy of online lectures within an introductory course on HCI. The objective was to augment the learning experience by introducing online lectures as a precursor to in-class sessions, thereby reallocating class time to more interactive, hands-on activities. Spanning 15 weeks, the semester was bifurcated, with one segment employing online lectures and the other adhering to conventional lectures. Interestingly, the findings revealed that students exposed to the online lecture format not only scored higher on assignments and exams relative to their peers in the traditional lecture segment but also perceived a more enriched learning experience. Furthermore, there was a discernible shift in their attitudes, favoring online lectures and innovative course structures. The research posits that online lecture methodologies can be as, if not more, pedagogically effective and engaging than traditional lecture-centric paradigms.

The paper referenced as [5] delves into the incorporation of research projects within a design-centric HCI course tailored for undergraduate computer science students. It underscores the challenges encountered when mentoring students through these research endeavors and the advantages of embedding research into the curriculum. The course's framework is elucidated, encompassing lectures on design tenets and theories, as well as the methodology for student presentations and assessments. Additionally, the article showcases selected research projects and their results, complemented by feedback from the students.

The study of Vieira et al. [6] introduces an innovative pedagogical approach aimed at enhancing student retention and comprehension in HCI courses. Merging traditional lecture formats with active and project-based learning components, this method leverages interactive educational videos and learning objects. The approach is bifurcated: the initial segment elucidates HCI's theoretical concepts, while the latter focuses on project-based learning exercises. The article further provides an in-depth exploration of the method, contextualizes it within related literature, and assesses its efficacy. Preliminary findings indicate a marked improvement in student retention and understanding of HCI topics using this method.

Wilcox et al. conducted an in-depth discussion of various teaching books and resources that are crucial in shaping HCI education [7]. These resources range from basic texts to more advanced materials on interaction design and usability testing that focus on specific interaction considerations, challenges, and opportunities inherent to specific devices and media types. Some examples include: video games, data input devices, display formats, virtual reality, collaborative interfaces, robots and drones, etc. The paper also cites a number of studies and papers that have contributed to the field, demonstrating an understanding of the existing review.

In addition, Read et al.'s paper [8] focuses on the importance of understanding and promoting children's participation in HCI design, research, and evaluation. Children are important users of interactive technology, and long-term stay at home has also increased children's interaction with technology. An HCI course for children focuses on ensuring that children gain valuable skills as they participate in research and design work. The course combines academic and industry studies with children. Participants in this course will learn about the core values, methods, and techniques for working with children in children-computer interaction (CCI) and child user experience. The course is designed to provide participants with practical handouts including roles, planning sheets, toolkits and checklists. The main focus is on empowering children and ensuring their valuable participation in the research, design and evaluation process.

III. Review of Interest-Based Teaching Method

Among the vast number of educational methods, the traditional classroom model has long dominated. This model is characterized by being teacher-centered, with educators disseminating information and students passively absorbing information, and has become the cornerstone of many educational institutions. While it provides stability and a structured learning environment, the rapidly changing world around us requires a more adaptive, dynamic approach to education. Recognizing this, educators have been exploring alternative teaching models. In the ever-evolving education landscape, methodologies and pedagogies are constantly changing to find the most effective ways to engage students and promote deep learning. Among these methods, the interest-based teaching method stands out, especially in our courses where this strategy has been used for more than 10 years [9]. This approach of putting students in control of their learning journey has proven transformative, fostering a culture of curiosity, collaboration and application.

Although HCI has been widely studied and researched in the scientific field, the teaching methods used to teach the subject remain relatively consistent, mainly surrounding problem-based learning (PBL) and case-based learning (CBL). Traditionally, HCI courses have relied heavily on PBL and CBL approaches. PBL encourages students to learn through the experience of solving open-ended problems, while CBL uses real-life cases to allow students to apply theoretical knowledge.

Both approaches have their merits and foster critical thinking and practical application. However, we identified a significant gap: students often lack sustained interest in ongoing and innovative research after completing the course. Recognizing the above gaps, we urgently need to reimagine the way HCI is taught. The central idea behind interest-based learning (IBL) is simple yet profound: use students' personal interests as catalysts for learning. Rather than having a predefined problem or case presented to them, students can come up with their own HCI projects rooted in their personal passions, whether it is playing the piano, cooking, or any other hobby.

Students generally reported being more interested in Media and Cognition topics when taught through an IBL approach. A notable observation was how many students took the initiative to further refine their projects even after the course officially ended. This self-driven continuation is a testament to the lasting impact of IBL. Students appreciated the opportunity to bring their unique personalities to their projects. This personal touch not only makes projects more meaningful to students, but also enriches the classroom experience with diverse projects reflecting a myriad of interests.

Media and cognition courses cover a wide range of topics, from media theory to cognitive psychology. This diversity provides students with multiple entry points to connect to their personal interests. The media landscape is constantly changing. IBL allows the curriculum to be flexible and adaptable to current trends that may be of interest to students. Here are a variety of ways to implement IBL in media and cognitive classes:

- Interest Checklist: Begin the course by taking an interest checklist. Understand which media platforms students engage with, which cognitive theories interest them, and which topics they are curious about.
- Flexible course design: Design a framework that allows for flexibility. For example, courses have core modules but leave space for student-led topics based on a list of interests.
- Project-based assessment: Allow students to work on projects related to their interests. For example, if students are interested in the impact of social media on cognition, they can design a study or create content that examines this in depth.
- Collaborative learning: Encourage students to form groups based on shared interests.
- Real-world application: Provide students with opportunities to apply knowledge in the real world.
- Guest lectures and workshops: Invite professionals from various media and cognitive science fields.
- Feedback mechanism: Collect feedback regularly to understand whether students feel their interests are being met, and adjust courses accordingly.

IBL in media and cognitive courses has many benefits, including:

- Enhanced engagement: When students study topics that interest them, they are more likely to engage deeply with the material.
- Better retention: Learning content that aligns with personal interests is often better retained as students find something personally relevant in the content.
- Skill development: IBL develops skills such as critical thinking, research, and independent learning, all of which are critical in the media and cognitive domains.
- Prepare for real-world challenges: By focusing on current, interest-related topics, students are better prepared to tackle the evolving fields of media and cognitive science.

On the other hand, teaching using IBL methods still has some challenges. For example, it is difficult to meet every student's interests. However, by grouping similar interests and taking a modular approach, educators can address a broader range of topics. Furthermore, traditional assessment methods may not always be suitable for IBL approaches, requiring the use of diverse assessment methods, including projects, presentations, and reflective journals. While delving into each interest can be time-consuming, we use a blended learning approach that combines classroom courses with online resources to allow students to continue exploring some interests in their own time.

IBL-approaches emphasize personal relevance and engagement, providing a new perspective on instructional media and cognition. By centering curriculum around students' passions, educators can foster deeper understanding, skill development, and a true love of learning. Despite its challenges, the advantages of IBL in terms of academic outcomes and skill development make it a valuable approach in the dynamic media and cognitive fields.

IV. AIGC-Based Semantic Communication Structure

In the context of the booming digital economy, the rise of digital intelligence brings both opportunities and challenges. One of the most significant advancements in addressing these challenges is the emergence of artificial intelligence-generated content (AIGC). The technology harnesses the power of AI to assist or completely replace manual content creation, tailoring content based on specific user input or requirements [10]. The rise of large-scale pre-trained models is a boon to AIGC. These models bring many benefits, including improved accuracy, adaptability, and efficiency of content generation. In addition, AIGC's industrial chain from algorithm development to end-user application is increasingly complete, supporting a wide range of industries and use cases.

Semantic communication is not just the transmission of messages, but ensuring that those messages are understood within their intended context. Modern semantic-aware networks often integrate AI and machine learning algorithms [11]. These algorithms benefit from semantic communication because the clearer the meaning of the data, the more accurately the algorithms can process and operate on it. As communication methods evolve, ensuring that the message (via semantic communication) and the medium (via semantic-aware networks) prioritize meaning is critical for effective and efficient communication.

Beginning in 2022, substantial models like GPT-3 are poised to gain gradual acceptance and widespread utilization within both academic and industrial circles. Our most recent iteration of the HCI course introduces a semantic communication

exercise, leveraged on large-model AI generation technology. This practice is engineered to assure efficient end-to-end transmission and reconstruction, along with the capability to retain visual signals to a diverse range of degrees. The proposed AI-generated semantic communication platform students proposed is a testament to the power of the interest-based approach. This platform addresses a critical challenge in communication technology: the retention capacity of visual signals. Visual signals, especially those with low retention rates, can often be lost or distorted during transmission. The platform evaluates these signals and ingeniously converts low-retention visual signals into textual cues. This conversion ensures that the essence of the information is retained, even if the original visual format is compromised. Once converted into textual cues, these data are transmitted using cutting-edge AI - generated technology. At the receiving end, the data are reconstructed, ensuring that the original message is conveyed accurately and effectively. Conversely, for visual signals with high retention rates, the platform employs a different strategy. Instead of converting them into textual cues, these signals are compressed based on their respective areas. This compression ensures efficient transmission without compromising the integrity of the information.

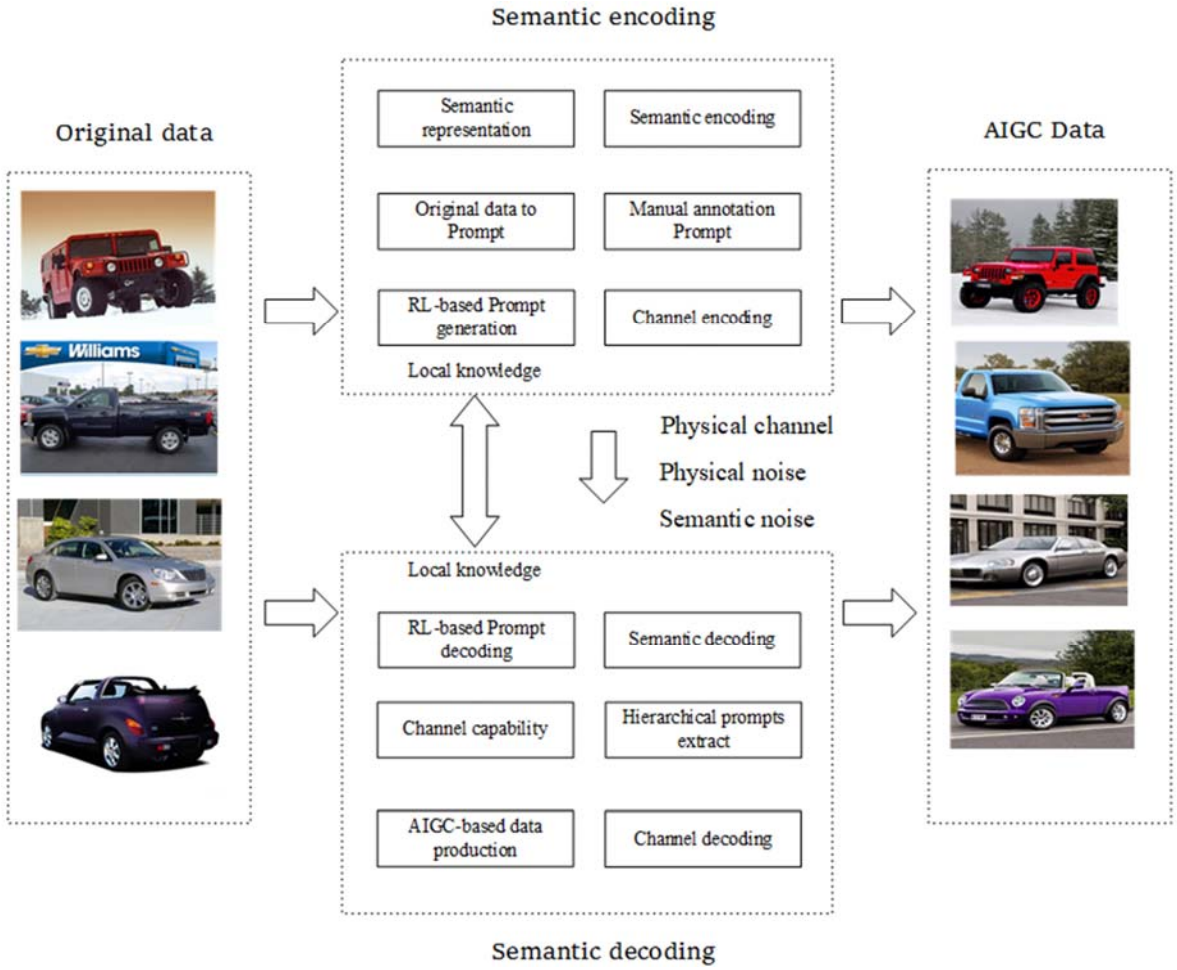

Fig. 1 AIGC Semantic communication platform

V. Conclusion

The overall goals of the Media and Cognition course are multifaceted. On the one hand, it aims to cultivate students' innovative thinking and ensure that they are not only consumers of knowledge but also contributors to the ever-expanding field of electronic information. On the other hand, the course attempts to blur the traditional boundaries between disciplines. By promoting the integration of engineering and management, and the integration of social sciences and humanities, the program strives to produce graduates who are both technically proficient and possess a broad worldview. The vision is to cultivate a new generation of talents with comprehensive qualities so that they can become valuable assets to society. Whether in telecommunications, broadcasting or online streaming, the development of AI-generated semantic communication platforms has deep and broad scientific research and application potential, helping to change the way visual data are transmitted and received. Furthermore, the very fact that students came up with such an innovative platform emphasizes the effectiveness of the interest-based approach. By allowing students to explore areas of personal interest and apply

course knowledge to real-world situations, educators are not just teaching facts but developing problem solvers, innovators, and future leaders.

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