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Leveraging Student-Generated Ideas (SGI) to Facilitate Socio-constructivist Learning and Conceptual Change: The Roles of Technology in SGI Learning Trajectories

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Abstract: This panel aims to facilitate an exchange between scholars specialized in various technology-enhanced socio-constructivist learning approaches with the common ground of placing Student-Generated Ideas (SGI) in the center of the learning trajectory. Despite varying theoretical underpinning and socio-cognitive mechanisms, these learning approaches similarly elicit ideas contributed by individual or groups of students in diverse forms and put them into the learners' classroom or online community space to advance their learning. Examples of such approaches are not restricted to those which will be explicated by the panelists, namely, seamless learning, knowledge building, guided student questioning, student-generated questions, ubiquitous learning log, and productive failure-based flipped classrooms, but may also encompass problem-based learning, project-based learning, computational thinking, STEM, design thinking, makers, etc. The roles of technology in facilitating and enhancing such learning trajectories will be discussed.

Keywords: Student-generated ideas, socio-constructivism, technology-enhanced learning, seamless learning, knowledge building, guided student questioning, student-generated questions, ubiquitous learning log, productive failure-based flipped classrooms

1. Introduction

This panel aims to facilitate an exchange between scholars specialized in various technology-enhanced socio-constructivist learning approaches with the common ground of placing Student-Generated Ideas (SGI) (Lam et al., 2016) in the center of the learning trajectory. Despite varying in theoretical underpinning and socio-cognitive mechanisms, these learning approaches similarly elicit ideas contributed by individual or groups of students in diverse forms (e.g., suggestions, questions, explanations, pieces of information, learning strategies, and/or artefacts) and putting them into the learners' classroom or online community space to advance their learning. Examples of such approaches are not restricted to those which will be explicated by the panelists, namely, seamless learning, knowledge building, guided student questioning, student-generated questions, ubiquitous learning log, and productive failure-based flipped classroom and project-based learning, but may also encompass problem-based learning, computational thinking, STEM, design thinking, makers, and jigsaw method`, etc.

The theoretical rooting of our SGI framework is conceptual change theory (Hewson, 1981). The theory is premised on how learning has the element of cognitive conflict and expounded the role of prior knowledge in students' learning (Pintrich, Marx, & Boyle, 1993). The theory sees learning as conceptual assimilation or accommodation (Posner et al., 1982). Underpinned by conceptual change theory, diSessa (1988) explicated "knowledge in pieces" (KiP) as fragmentary sub-structures of cognition. diSessa describes KiP as unstable and emergent conceptions, as opposed to the more stable but inaccurate cognitive structures of misconceptions. Such a Vygotskian view makes the distinction between a learner's everyday concepts and non-spontaneous concepts. Vygotsky described the former as formed during a learner's activity through interaction with social others in everyday life. Thus, for example, everyday concepts manifest themselves in the way learners use words in everyday language, as opposed to canonical concepts which are mastered during traditional classroom instruction.

Vygotsky (1986) argued that when a learner is confronted with novelty in an everyday context, (s)he gradually develops the verbo-logical structure which brings into existence the everyday concept. He described such structures as developed initially through the accumulation of 'syncretic heaps' and then through the formation of complexes (or pseudo-concepts). Because of this gradual heap-to-complex-to-concept process, the development of everyday concepts is from *bottom to top*. This is in contrast with the development of everyday concepts with the development of canonical concepts – the latter is being from *top to bottom*. That is, the development of canonical concepts starts with a formalized explanation, and is later connected to the learner's everyday experience.

The Vygotskian explication on the bottom-to-top developmental trajectory of everyday concepts, is indeed offering a common academic underpinning to the SGI framework. In this framework, we refer to an initial idea put forward by student(s) as a **raw idea**. The raw idea is then gradually evolved through SGI-based learning activity(ies) into an **endmost idea**. In between a raw idea and an endmost idea, one or more **intermediate ideas** might be generated.

We conceptualise raw/endmost ideas as representations, reifications or utilisations of certain concepts developed in students' minds. Raw ideas and endmost ideas are not dichotomous. Rather, they are situated at both ends of a continuum (with intermediate ideas in between) that represents the evolution of an SGI with varied levels of complexity, maturity or sophistication. Additionally, SGIs are typically emergent and open-ended (i.e., without a standard solution) in nature. Thus, perhaps defying the traditional conception in classroom instructions, an endmost idea is not necessarily a "perfect" one. An **idea evolution** process can be concluded when the teacher and/or the students believe that the learning goal is accomplished in view of the sophistication of the developed idea.

We also introduce **meta-ideas**, the operators that students may apply on one or more SGIs to evolve it/them. Examples of such operators are elaborating, critiquing, evaluating, reifying, remodelling, connecting (with other SGIs, prior knowledge or experience, etc.), synthesizing, abstracting, rising above, etc.. A significant objective of the SGI-driven learning is to elicit, and therefore develop students' abilities in applying these meta-ideas akin to 21st century competencies.

2. Abstracts of Individual Panelists' Presentation

2.1 Seamless Learning (Lung-Hsiang WONG)

Seamless learning is when a person experiences a continuity of learning, and consciously bridges the multifaceted learning efforts, across a combination of locations, times, technologies or social settings (Sharples et al., 2012; Wong, 2015). Seamless learning foregrounds the unique ecological resources in various learning spaces including tools and people which/who could facilitate multifaceted tasks (Rusman, 2019), e.g., the classroom for learning preparation and consolidations, physical spaces for situated/authentic learning, cyberspace for information seeking/sharing and peer discussions, etc. Through such learning trajectories, students may generate various forms of ideas, encompassing the intermediate or final student artifacts as representations of their knowledge states. For example, an idea incubated in-class may be practiced/reified in authentic settings, and later be scrutinized, enriched, transformed and/or challenged within the social learning spaces, with diversified perspectives, knowledge and experiences mediating the socio-constructivist discourse (Lewis, Pea, & Rosen, 2010). Hence, both the "idea" and the learning process itself are constantly "recontextualized," which would lead to deep learning.

The (almost) omnipresence of the Internet and mobile devices in our modern life is indeed conducive for the development or adoption of online learning platforms or digital tools to enhance and support individual students' seamless learning journey. In particular, the net-persistent social media which support easy and rapid multimodal web content creation, sharing, and elicitation of peer inputs has been regarded as natural tools to mediate generation and transformation of ideas across learning contexts (Wong, Chai & Aw, 2017). Henceforth, whereas there is always a possibility that seamless learning can be enacted without ICT (Information and Communication Technology) support, the technology could however play multiple roles such as metacognitive and cognitive tools, communicative and collaborative tools, and most importantly context-bridging tools, which would substantially enhance seamless learning experience and outcomes.

2.2 Knowledge Building (Chew Lee TEO)

Knowledge Building Classroom is social and collaborative in nature (Scardamalia & Bereiter, 2014). A teacher facilitating the KB classroom is less concerned about getting the correct answers quickly but more about sustaining the discussion in class that goes beyond knowledge sharing. The discursive practice focuses on students working flexibly and creatively with ideas. It involves sharing ideas and information, connecting and improving these ideas. One of the unique processes in KB discourse is to support students in identifying the "promising ideas" from all of the class' ideas to make collective decisions regarding the most promising directions for subsequent inquiry (Chen et al., 2015). The basis of the knowledge building process is essentially an idea improvement path. The emerging, interactive, and ephemerous nature of ideas make it quite impossible to trace the path, let alone label them as raw, intermediate, and end-most ideas. There have been many studies exploring various mechanisms to boost student capacities to advance ideas, e.g. automated feedback and assessment tools (Resendes & Chuy, 2014), idea identification and analysis (Lee et al., 2015), Promisingness idea tool (Chen et al., 2015) and the Curriculum-idea-analytics (Teo et al., 2021). All these studies highlighted the importance of students' role in sustainable idea improvement within the Knowledge-Building Discourse and the emerging nature of this idea improvement trajectory. In this panel, we will draw on these analyses and technological work on idea development in KB classrooms to discuss students' agency and teachers' design capacity in SGI approach. We will look at the risk of over-structuring such creative idea work in the formal learning setting and what it means for teachers to support idea development.

2.3 Guided Student Questioning (Longkai WU)

Guided student questioning serves a heuristic purpose in enabling students to construct knowledge in their learning experiences (Pedaste et al., 2015; Stokhof, De Bries, Martens, & Bastiaens, 2017). Students are not likely to ask questions spontaneously and need to be encouraged and taught to do so. The teachers' questions can function as models for students to pose similar ones for their peers to answer, thereby reinforcing conceptual understanding through more practice. These uses extended teachers' ability to engage students and finely tune their teaching to focus on the misconceptions - and probably resulting in better learning. With the right facilitative conditions comprising relevant stimuli to trigger curiosity, and the support mechanisms such as computer-aided teacher systems, students are more inclined towards asking questions. Teachers foster whole class discussion about science using effective questioning techniques and employ targeted strategies and tasks with the use of technology to offer adequate guidance, structure, and focused goals.

2.4 Student-generated Questions with Technology-Mediated Socio-constructivist Learning Approaches (Fu-Yun YU)

Broadly defined, the student-generated questions (SGQ) approach involves having students reflect on prior classroom activities or related educational experiences and generate questions with answers around the areas they deem important and relevant for the multi-purpose of assessment of learning as well as assessment for and as learning (Yu & Wu, 2020). Empirical evidence generally substantiates its efficacious effect for promoting learners' cognitive and affective development (Kul & Çelik, 2020; Rosli, Capraro, & Capraro, 2014; Zuya, 2017) while helping teachers identify misconceptions held by students (Bekkink, Donders, Kooloos, de Waal, & Ruiter, 2016). Despite that SGQ may appear to concern primarily about individual knowledge construction, how socio-constructivist learning approaches/design can be tactically and versatilely brought in and how fluid, social interaction spaces can be created for SGQ with the support of network technology will be the focus of this talk.

Specifically, two such learning approaches/design to augment the effects of SGQ are targeted — peer-assessment and the citing of peer-generated questions. Issues surrounding the design and development of multiple social spaces afforded by network technology to affect the quantity and quality of social interaction and online discourse experience will be highlighted and demonstrated. Additionally, studies that examined the following will be shared: if and how learning trajectory is changed; if and how idea/knowledge (in terms of refinement, extension, and consolidation) is promoted; if and how a distinct mode/design prevails (in terms of learners' perceived usefulness and preference); and if and in what aspects learning outcomes differ among the versatile created online spaces.

2.5 Ubiquitous Learning Analytics (Hiroaki OGATA)

One of the challenges of CSUL (Computer Supported Ubiquitous Learning) research is capturing what learners have learned with the contextual data, and reminding the learners of it in the right place and the right time. We have developed a student-generated ubiquitous learning log system called SCROLL (System for Capturing and Reminding of Learning Log) (Ogata et al., 2011). Student-Generated Ubiquitous Learning Log (SGULL) is defined as a digital record of what learners have learned in daily life using ubiquitous technologies. It allows the learners to log their learning experiences with photos, audios, videos, location, QR-code, RFID tag and sensor data, and to share and to reuse them with others. Using SCROLL, they can receive personalized quizzes and answers for their questions. Also, they can navigate and be aware of their past SGULLs supported by augmented reality view. Furthermore, this presentation will give the evaluation of applying this system to language learning scenarios. By constructing learning trajectories which comprise of accumulated SGULLs with contextual information such as what, when, where, and how learners have learned and by analyzing them, the learners can be supported to learn more effectively.

2.6 Productive Failure-based Flipped Classroom and Project-based Learning (Yanjie SONG)

Premised on socio-constructivist theories for collaborative problem-solving, productive failure-based instructional design first engages students in unguided problem solving to elicit their prior knowledge, particularly in the failure to solve the problem, followed by using this information to consolidate and aggregate new knowledge (Kapur, 2016). The failure stems from the fact that learners are commonly unable to generate or discover the correct solution to the novel problem by themselves; on the other hand, they are able to generate sub-optimal or even incorrect solutions to the problem, the process can be productive in preparing them to learn better from the subsequent instruction that follows (Kapur, 2014). This instructional design was adopted in recent two studies in "productive failure-based flipped classroom" (Song & Kapur, 2017) and "productive failure-based project-based learning" (Song, 2018). In these studies, students have been involved in generating their own ideas collaboratively to solve their problem under investigation without teacher facilitation, followed by the teacher's scaffolding to help them consolidate new concepts after the problem-solving process. The findings show that students have enhanced their problem-solving skills and enhanced their learning outcomes.

In collaborative problem-solving, learners need to strive for a solution to a driving question and create a series of artifacts that represent understanding of the driving question (Blumenfeld et al. 1991). In this process, technology plays an important role in helping learners' access learning resources, create artifacts, analyse data, document their collaborative inquiry trajectories in different settings and make their thinking visible (e.g., Song 2018).

3. Discussion and Conclusion

The SGI approach constitutes a teaching and learning philosophy that defies the traditional instructional process of explicit teaching → practice →production (or assessment) where students' perfect or near-perfect performance is desired or privileged even way back to their first "practice/reinforcement".

Instead, the six techno-pedagogical models to be shared in this panel exemplify an alternative belief that the ideas or artifacts generated by the students at the early stage can be naïve, immature or constituting misconception or errors. These should not be seen as learning deficits. Rather, such early imperfection is the part-and-parcel of (socio-)constructivist learning that would offer opportunities for individual and collective inquiry, reflection and knowledge creation. By situating these learning approaches in technology-rich environments, students (and teachers) would then be able to leverage a variety of technological affordances to connect their SGI experience in and out of the classroom, conveniently record their rough initial ideas or produce more sophisticated, making-thinking-visible artifacts (perhaps with the aid of the abundant resources and reference materials which are searchable from the Internet, or visualization tools to assist their data analysis or identify connections between ideas or concepts, etc.), and make them shareable in the social learning space for ongoing collaborative knowledge improvement.

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