Digital Competence for Industrial Revolution 4.0: Implications to Teacher Professionalism

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Introduction

Unprecedented advancements in technology have been taking place very rapidly as evidenced by the advent of Industrial Revolution 4.0 (IR 4.0) which is characterized among others by big data, internet of things, 3D printing, and robotics, all of which are related to digital technologies. Given this reality, digital competence is important. Viewed as "the vital 21st-century skill for teachers and students," it is "the confident and critical usage of the full range of digital technologies for information, communication, and basic problem-solving in all aspects of life" (School Education Gateway, retrieved on 12 February 2020). Digital technologies are "electronic tools, systems, devices, and resources that generate, store, or process data. Examples include social media, online games, multimedia, and mobile phones" (State Government of Victoria, Australia, 2019). The five areas of digital competence are information and data literacy, communication and collaboration, digital content creation, safety, and problem solving; and each area has specific digital competences (School Education Gateway, retrieved on 12 February 2020). This implies that teachers themselves must be digitally competent in these areas so that they can effectively facilitate the development of digital competence in their students.

Underlying the provisions of the Philippine Professional Standards for Teachers or PPST (2017) is the principle of continuous improvement and lifelong learning of teachers. And so, in the context of IR 4.0, teachers are expected to upgrade and update their knowledge and skills and exercise values that are necessary for the fast changing times. Content knowledge and pedagogy, learning environment, diversity of learners, curriculum and planning, assessment and reporting, community linkages and professional linkages, and personal growth and professional development are PPST's seven domains which together with their corresponding strands broadly covers the specific digital competences.

This paper will examine some of the specific digital competences under four of the areas of digital competence and relate them to pertinent standards stipulated in five of the domains of PPST for the proficient, highly proficient, and distinguished career stages of teachers. In the process, it will draw implications to teacher professionalism.

Implications to Teacher Professionalism

Information and data literacy. This competence includes browsing, searching, filtering, evaluating, and managing data, information, and digital content.

Available on the web is a wealth of data, information, and digital content that teachers can access for their professional learning which ultimately can inform their professional practice. They can efficiently and effectively make their access if they have the skills of browsing, searching, and filtering. A critical mind is necessary to evaluate if the resources that they access come from credible and reliable sources. Through reflection of their purposes and contexts,

teachers can determine, use, and manage data, information, research results, e-books, videos, podcasts, lesson plans, activities, presentations, apps, and the like, that can deepen and broaden their knowledge of content and pedagogical content to enhance their teaching and assessment practices. Such competence is consistent with the strand professional reflection and learning to improve practice which is under the domain Personal Growth and Professional Development in the PPST. It is noteworthy that in using these resources on the web, giving credit to whom credit is due by acknowledging the source of ideas through citations is a good practice and demonstrates intellectual honesty.

Based on the author's class observations, integrating in a lesson, a video clip taken from the web, is an example of a practice that builds upon information and data literacy. Under PPST's Curriculum and Planning domain, proficient teachers are expected to "select, develop, organize, and use appropriate teaching and learning resources, including ICT, to address learning goals." Appropriateness of the resource should not only be in relation to the attainment of lesson objectives but also in relation to the learners' needs, characteristics, and contexts as provided for in the domain Diversity of Learners of PPST. Still in PPST's Curriculum and Planning domain, proficient teachers are expected to "plan, manage, and implement developmentally sequenced teaching and learning process to meet curriculum requirements and varied teaching contexts." This implies that in adopting or adapting resources such as a video clip into a lesson, the teaching sequence should be designed so as to achieve coherence by establishing clear connections among the ideas presented in the diferent parts of a lesson as well as ideas presented across lessons. Hence, it is very important for teachers to process the ideas presented in the video by finding out if the students correctly and clearly understood what they have viewed and listened to, what these understandings are, and how these relate to their current lesson as well as to their previous lessons.

Again, another example of building upon information and data literacy based on the author's class observations is the lesson integration of an interactive courseware in elementary school mathematics in English aimed at developing students' higher order thinking skills as they learn mathematics. In the different lessons in the courseware, students are required to think of various ways of solving a problem thereby developing their creativity and to respond to questions that capture their misconceptions thereby developing their critical thinking. Developed by UP NISMED in collaboration with the Department of Science and Technology Science Education Institute (DOST-SEI), DOST-Advaced Science and Technology Institute (DOST-ASTI) and the Department of Education (DepEd), the resource in which each lesson consists of the lesson development, exercises, and assessment, can be downloaded from the website of DOST-SEI and can run on PCs, laptops, and netbooks. Teachers translate the lessons in grades 1 to 3 since mother tongue is used to teach mathematics in these grades. The competences needed by teachers who use the courseware in their teaching are aligned with the expectation from highly proficient teachers to "promote effective strategies in the positive use of ICT to facilitate the teaching and learning process" and to "develop and apply effective teaching strategies to promote critical and creative thinking, as well as other higher order thinking skills," under PPST's Content Knowledge and Pedagogy domain.

Still another example of building upon information and data literacy based on the author's involvement in teacher training programs is using GeoGebra, a free downloadable dynamic software from the web, to actively engage students in the mathematics teaching-learning process. For instance, teachers can develop tasks that will require students to individually or in

groups, carry out using GeoGebra, mathematical explorations or investigations in algebra, geometry, statistics, and trigonometry, say to see the effect of changing a certain quantity on other quantities. In the process, students learn to analyze, make conjectures, predict, generalize, evaluate, and justify. Later, they can prove the conjectures that they have formed based on the relationships that they have observed among the quantities. For this kind of student engagement to happen, teachers have to structure the learning environment so that it will lend itself to student active involvement. Such is an expectation from proficient teachers as stipulated in PPST's domain Learning Environment. Specifically, they are to "manage classroom structure to engage learners individually and in groups, in meaningful exploration, discovery, and hands-on activities within a range of physical learning environments." They are also expected "to maintain supportive learning environments that nurture and inspire learners to participate, cooperate, and collaborate in continued learning." Moreover, they are to "apply a range of successful strategies that maintain learning environments that motivate learners to work productively by assuming responsibility for their own learning."

Developing lessons that integrate or make use of available resources, say digital content from the web, can be done in the context of lesson study since this teacher professional development model fosters collaborative professionalism (Hargreaves and Connors 2018). For instance, guided by a long-term goal or research theme, teachers, by working collaboratively, can ensure that the correct teaching sequence is followed, there is lesson coherence, and the lesson objectives are addressed. They can also ensure that there is processing of the digital content in terms of building up students' understanding of the lesson. During the research lesson implementation, observing how the digital content contributes to students' thinking and learning and discussing about such contribution during the post-lesson reflection are opportunities that lesson study provides. These activities are aligned with the PPST's domain Curriculum and Planning specifically in the strand professional collaboration to enrich teaching practice, in which proficient teachers are expected to "participate in collegial discussions that use teacher and learner feedback to enrich teaching practice."

Communication and Collaboration: This competence includes interacting, sharing, and collaborating through digital technologies and netiquette.

Teachers can interact among themselves, share information and resources, and collaborate to accomplish certain tasks using digital technologies such as facebook, Skype, and emails. In PPST's domain Personal Growth and Professional Development particularly in the strand professional links with colleagues, it is stipulated that very proficient teachers should be able to "contibute actively to professional networks within and between schools to improve knowledge and enhance practice." UP NISMED's KaSaMa Teachers' Online Community involving science and mathematics teachers and teacher educators as well as UP NISMED academic staff, is an exampe of an online professional network. UP NISMED has a repository of relevant memoranda from DepEd, learner's modules, and teacher's guides among others, which the community can access. Based on their knowledge and experiences teachers interact about how to address common problems, for example, those related to teaching science through inquiry. UP NISMED also conducts webinars such as on science inquiry, assessment, lesson study, and new topics in the K to 12 science curriculum in which teachers belonging to the community can ask questions to the resource person. Members and resource persons come from the Philippines and abroad. Teachers' activities such as these are also consistent with the expectation from highly proficient teachers to "initiate professional reflections and promote learning opportunities with colleagues

to improve practice" which is under PPST's Personal Growth and Professional Development domain.

Another example of using digital technologies for communication and collaboration was the cross-border education cooperation between the Philippines and Malaysia in 2017 undertaken in relation to the APEC-Tsukuba-Khon Kaen Lesson Study Project. Through emails and Skype, the lesson study teams of the two countries collaboratively developed a lesson on energy efficiency which the teacher of each country taught simultaneously in their respective class via Skype. During the lesson implementation, students from each country took turns in asking and responding to questions of students from the other country resulting to their better understanding and appreciation of how energy is consumed and conserved in the two countries.

The two examples cited show that due to the availability of digital technologies, constraints in finances, time, and distance are no longer hindrances for teachers to interact, share, and collaborate.

Another competence in communication and collaboration is netiquette (short for internet etiquette), a code of "good behavior" in the internet (TechTerms 2017). Correct and proper online communication should be based on values and traits such as honesty, reliability, accountability, respect, discreetness, good judgment, keeping confidences, sensitivity, clarity, and conciseness.

Digital Content Creation: In relation to digital content, this competence includes developing, integrating, and programming. (The succeeding discussion on ***Problem Solving*** will include programming.)

As earlier mentioned in information and data literacy, teachers can integrate resources on the web into their lessons depending on their purpose. Besides this, teachers can develop digital content such as podcasts, e-books, and programs and also integrate existing digital content to the ones that they are developing. Activities like these are consistent with PPST's Curriculum and Planning domain in which proficient teachers are expected to "select, develop, organize and use appropriate teaching and learning resources, including ICT, to address learning goals."

An example of podcasts found in UP Diliman's College of Mass Communication website are UP NISMED's *Go Teacher Go!* radio program's episodes aired over UP's community radio. School teachers are the program's discussants most of the time. They discuss activities, lessons, or teaching strategies that can enable students to understand better a particular topic and address students' common difficulties and misconceptions in science and mathematics.

Besides podcasts, UP NISMED staff created an interactive e-book using d-book on *Understanding Earthquakes* based on a mathematics research lesson that used science as a context. They developed the lesson collaboratively with a group of high school mathematics teachers through lesson study. It is uploaded in the websites of CRICED and UP NISMED.

Problem Solving: This includes the creative use of digital technologies.

There are real-life problems that may be solved using digital technologies. Following are some examples. For identifying the route that avoids heavy traffic, drivers use the Waze app in their mobile phones. When abroad, so as to avoid getting lost, a foreigner can use Google maps in his

mobile phone. Instead of wasting time waiting for a taxi to pass by a street, one can simply stay where he/she is and just book a GrabTaxi and be informed about the taxi fare, the amount of time that a taxi within the vicinity will fetch him/her, and the amount of time that the taxi will reach the destination. Then he/she can just go to the pick-up point when the taxi arrives. To avoid long queues, one can shop online. To avoid rushing, one can do online flight check-in. To save time in searching for relevant journal articles for a research, one only has to encode the key words in Google search for a host of choices to come out.

A creative use of computers, a digital technology, is problem solving. In making a computer solve problems, one has to engage in computational thinking. According to Jeanette Wing, a computer scientist, "computational thinking is the thought processes involved in formulating a problem and expressing its solution(s) in such a way that a computer – human or machine – can effectively carry it out" (Wing, in Araya et al 2019). To know what computational thinking entails, one has to be familiar with its elements which consist of concepts and practices (Grover and Pea 2017). The concepts include logic and logical thinking, algorithms and algorithmic thinking, patterns and pattern recognition, abstraction and generalization, evaluation, and automation. The practices include problem decomposition, creating computational artefacts, testing and debugging, iterative refinement (incremental development), and collaboration and creativity. Mathematics content and mathematical processes which are problem solving, reasoning, connection, communication, and representation involve most of these concepts and practices. Hence, computational thinking can be developed in mathematics teaching and learning. Engaging in computational thinking is consistent with PPST's Content Knowledge and Pedagogy domain specifically the expectation from highly proficient teachers to "develop and apply effective teaching strategies to promote critical and creative thinking, as well as other higher-order thinking skills."

According to Grover and Pea (2017), programming is an especially useful platform for teaching computational thinking since it brings together several of the elements – both concepts and practices – that are central to computational thinking.

On 3 February 2020, the author observed the results of the efforts of a group of teachers in Cavite National Science High School in relation to their Project PRISM (Promoting Robotics Integration in Science and Mathematics). In particular, their problem was how to show to the students of a grade 7 Science class what velocity and acceleration mean, among others. So the teachers programmed the robots which are in the form of a car to solve the problem. The car's casing was produced using the school's 3D printer. The outdoor activity involving the robots that the students performed generated data on time and distance which were used as basis for determining speed, velocity, and acceleration that the students later represented visually using graphs. Besides their excitement in performing the hands-on activity, the connection between the physical meaning and the visual representation of velocity and acceleration became very clear to the students. This innovative approach in teaching velocity and acceleration was collaboratively conceptualized by two Research teachers, one of whom is the Robotics Club adviser and a Science teacher.

In the school's Robotics Club where interested students are taught to program robots, some members have become better programmers than their Club adviser. They also have been participating and winning in local and international competitions. Inspired by this achievement, the local DepEd officials plan to train teachers of other public high schools in the place on

robotics with the teachers in Project PRISM as trainers using the materials that they have developed. When this plan is actualized, then based on PPST's Domain on Curriculum and Planning, the group of teachers may be considered as distinguished teachers who "model exemplary skills and lead colleagues in the development and evaluation of teaching and learning resources, including ICT, for use within and beyond the school."

Conclusion

IR 4.0 necessitates digital competence in terms of information and data literacy, communication and collaboration, digital content creation, and problem solving. In order to facilitate the development of digital competence among students, teachers themselves must be digitally competent. By meeting the standards set forth in the PPST for the different stages of their career with the areas of digital competence as context as they relate to the different domains of PPST, teachers digital competence can be developed. These domains are Content Knowledge and Pedagogy, Learning Environments, Diversity of Learners, Curriculum and Planning, and Personal Growth and Personal Development. Thus, digital competence can be considerd as an integral part of teacher professionalism.

Developing their own digital competence can be embedded in teachers' regular practices such as preparing and teaching lessons. Guided by a research theme, teachers' engagement in lesson study can help them to be digitally competent as they collaborate in designing and implementing lessons, and reflecting on what they have learned about student thinking and learning through those lessons.

Problem solving is definitely prevalent in IR 4.0. Being anchored on problem solving, developing computational thinking is necessary for digital competence.

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