Towards a Framework for Integrating Digital Portfolios into Teacher Education

Abstract

A problem with applications of innovations and technological tools such as the digital portfolio is that, while detailed conceptions and examples of digital portfolios exist, there is a chasm of practical advice that is sufficiently generic for guiding considerations on how to integrate digital portfolios into different learning environments. In this paper, it is argued that a powerful framework for guiding thinking about the integration of digital portfolios into teacher education is provided by cultural-historical activity theory or CHAT. CHAT is useful because it has been shown to provide a clear operational framework for the design of learning environments that support the integration of various technological tools.

Introduction

Digital portfolios comprise a collection of documents and evidence of a teacher's knowledge, skills and experience (Wray, 2007, 2008) and they have gained considerable traction in the field of teacher education in recent years. In teacher education, portfolios are recognized for their value in documenting and describing student teachers' knowledge, competencies, and beliefs as a teacher and for demonstrating these to faculty and prospective employers. It is also a step towards developing a professional portfolio for career purposes (Lynch & Purnawarman, 2004; Masters, 2016; Oakley, Pegrum, & Johnston, 2014). Digital portfolios provide faculty with evidence of student teachers' achievement of programme goals, and enable them to demonstrate progressive knowledge and skill accumulation (Lynch & Purnawarman, 2004). Digital portfolios can be used as a tool for student teachers to reflect on their experiences and a platform to craft their philosophy of teaching (Hamilton, 2018; Hopper et al., 2018; Stone, 1998). Portfolios are further viewed as a means for helping student teachers make connections between theory and practice (Lynch & Purnawarman, 2004) and are viewed as being beneficial for reducing the oft-noted theory-practice divide (Girot, 2000; Hamilton, 2018; Harris, Dolan, & Fairbairn, 2001). Loughran and Corrigan (1995) summarised the utility of the portfolio for teacher education as being firstly a tool for reflecting on learning and secondly, as a way of gaining new insights into accomplishments in teaching.

The potential benefits that digital portfolios offer from a theoretical or institutional perspective have been heavily emphasised, while their actual use and uptake remains less than spectacular. While widely endorsed in theory, digital portfolios remain hard to implement and integrate in practice (Haggerty & Thompson, 2017; Nagle, O'Connell, & Farrelly, 2019; Poole et al., 2018; Scully, O'Leary, & Brown, 2018).

The literature on integration and implementation reveals some challenges that need to be addressed. For example, the lack of voice and buy-in from all key stakeholders involved, competing demands exerted on faculty and students, as well as opposing roles and purposes of the portfolio (e.g., Scully, O'Leary, & Brown, 2018; Haggerty & Thompson, 2017). Luerra, Brunvand, and Marra (2016) note the need to navigate the politics that exist between administrators and faculty in higher education, while technical challenges have been observed by Nagle, O'Connell, and Farelly (2019). Poole and colleagues (Poole, Brown, McNamara, O'Hara, O'Brien, & Burns, 2018) review some of the challenges and barriers in the Irish education system and highlight the need to address the disconnect between digital portfolios, curricular goals and demands, as well as goals of the education system. In the context of teacher education, perceived contradictory demands by student teachers, additional pressures arising from the increased workload and insufficient technological skills have been documented (e.g., Totter & Wyss, 2019).

As a result, researchers contend that a clear cohesive overall vision and blueprint are needed before advances can be made in integrating digital portfolios into education. This requires a common understanding and purpose of the digital portfolio (Poole, Brown, McNamara, O'Hara, O'Brien, & Burns, 2018). Ad hoc implementation attempts are increasingly viewed as unviable. There needs to be sound support within the programme as well as the wider organisational systems and processes and national movements. Support networks and policy developments that are consistent and in alignment with the digital portfolio initiative are necessary (Haggerty & Thompson, 2017; Nagle, O'Connell, & Farelly, 2019; Poole, Brown, McNamara, O'Hara, O'Brien, & Burns, 2018; Watson, Kuh, Rhodes, Light, & Chen, 2016). There is a need for a shift from a silo-based model (Nagle, O'Connell, & Farelly, 2019) to "a mature institutional approach where the ownership and the disruptive nature of eportfolio implementation are fully considered by a wide range of stakeholders" (Joyce, Gray, & Hartnell-Young, 2010, p. 26).

In recognition of this view, a few researchers have begun to propose overarching frameworks with desiderata for deliberation. Bass and Eynon (2018) for example, propose a general framework of questions that could guide institutional decision-making, investments, and ongoing institutional reflections on how institutions of higher learning can be transformed digitally. But their framework bears applicability to the integration of digital portfolios. Poklop and Peagler (2010) proposed a eportfolio planning framework to guide the planning and implementation decisions for successful eportfolio integration. Their framework involves many pedagogical and procedural decisions including inputs such as curricular and assessment goals, considerations about the design and integration of the eportfolio and desired results. More recently, Matthews-DeNatale, Blevins-Bohanan, Rothwell and Wehlburg (2017) discuss key design considerations in fostering inquiry, reflection, and integration through digital portfolios at different levels of the organisation so as to make individual learning and organisational development intentional. They consider design questions at different levels including courses and programs, institutional initiatives, institutional learning, to connections beyond the institution. Other researchers at the Connect to Learning (C2L) project coordinated by the LaGuardia Community College (CUNY), in partnership with the Association for Authentic, Experiential and Evidence-Based Learning (AAEEBL) have contributed to this area. Researchers from C2L analysed the strategies needed to implement digital portfolios effectively. They suggest that effective eportfolio initiatives intentionally focus on five interlocking sectors: pedagogy, professional development, outcomes assessment, technology, and how scaling up is carried out. This framework goes beyond the eportfolio initiative in the classroom to also look at students, faculty, departments, programs as well as broader institutional structures (e.g., Eynon & Gambino, 2017; Eynon, Gambino, & Török, 2014).

Although the digital portfolio field has matured, there is a chasm of holistic, comprehensive and sufficiently generic practical advice for guiding considerations on how to integrate digital portfolios into different learning environments. Further, there is a need for more work to be done in terms of finding clear and comprehensive frameworks to guide the design of digital portfolio initiatives and which support planning and implementation for effective practice (Eynon & Gambino, 2017; Nagle, O'Connell, & Farelly, 2019). As such, more research into how digital portfolios can be integrated into different contexts or programs, including teacher education, is

needed. While there is broad agreement as to the need for a unified framework and good governance in the whole digital portfolio ecosystem, more work needs to be done in this area.

A powerful framework for guiding thinking about the integration of digital portfolios into teacher education is provided by cultural-historical activity theory or CHAT (Author - Removed for Blind Review). For digital portfolios to be successfully integrated into teacher education, we need a good understanding of how digital portfolios are intertwined with reference to its context of use and a framework that supports this endeavor. CHAT has the potential to provide a clear operational framework for the design of learning environments that support the integration of various technological tools (e.g., Jonassen & Rohrer-Murphy, 1999; Lim, 2006, 2007; Lim & Hang, 2003). It enables a systemic analysis rather than studying piecemeal components (Barab, Barnett, Yamagata-Lynch, Squire, & Keating, 2004). The conceptual tools and common vocabulary offered by CHAT enables researchers to analyze digital portfolios in its authentic context in a manner that is both meaningful and manageable. It enables researchers to capture complexity in its wholeness, from a systemic lens, as well as to examine particular features and their contribution to the entire structure. These are benefits not necessarily addressed by other theoretical perspectives (Hardman, 2005; Jaworski, Robinson, Matthews, & Croft, 2013; Mwalongo, 2016; Yamagata-Lynch, 2010).

Through affording the identification of contradictions and tensions, CHAT affords help to practitioners and administrators to ascertain root causes of problems. Such forms of analyses are crucial for establishing shared visions for the solution of contradictions (Engeström, 2000). By using CHAT, scholars and leaders can study new educational innovations or existing processes to discover the facilitators of and barriers to change, with due considerations given to the sociocultural context (Larsen et al., 2017).

Cultural-Historical Activity Theory (CHAT)

According to CHAT, the unit of analysis is the activity system, defined as "object oriented, collective, and culturally mediated human activity" (Engeström & Miettinen, 1999, p. 19). Engeström (1987, 1993, 1999) represents the activity system in terms of an 'activity triangle' (see Figure 1). According to Engeström's (1987, 1993, 1999) activity theory, the activity system is a holistic entity that includes the 'subject' or individual, who is motivated by an 'object' or goal that ultimately adds on towards the attainment of an 'outcome'. The 'subject' acts with the use of mediating 'tools' that can be physical or psychological. The 'subject' exists within a 'community' and is governed by its 'rules', both implicit and explicit and the 'division of labour' that exists within the 'community'. The 'division of labour' can be horizontal or vertical. A horizontal 'division of labour' refers to the sharing and distribution of duties and responsibilities by members of the community. A vertical 'division of labour' is exemplified by distinctions between members of the community in terms of power and prestige. The relationship between the 'subject' and the 'object' is mediated by 'tools' and is focused on "production". The relationship between the 'subject' and the 'object' is mediated by the 'community' and is focused on "consumption". The relationship between the individual 'subject' and the members of the 'community' are mediated by 'rules' and is characterised as "exchange" while the relationship between the 'community' and the 'object' is mediated by the 'division of labour' and is described as "distribution" (e.g., Engeström, 1987; 1993; 1999; Roth & Lee, 2007). CHAT further uncovers contradictions or tensions, within the activity system. Contradictions are "problems, ruptures, breakdowns, [or] clashes" in activities (Kuutti, 1996, p. 34). An investigation into contradictions or tensions enable us to understand the reasons behind why there is a failure to achieve outcomes (Divaharan & Lim, 2010).

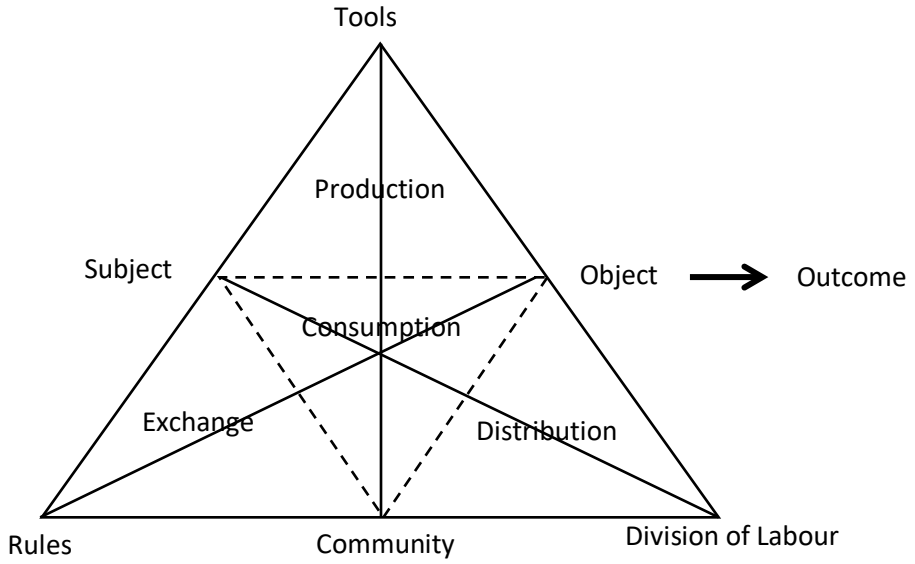

Figure 1. General Model of an Activity System (Engeström, 1987, p. 78).

Uncovering the Contexts of Digital Portfolio Integration

CHAT can be used to understand and unpack the different levels of a context. These contexts may range from microlevel systems such as those of interactions between individuals to broader macrolevel systems such as institutions, their blueprints and implementation efforts (Larsen, 2019). Cole's (1995) 'garden-as-culture' metaphor provides us with one lens with which to appreciate the relationships between the different contexts or activity systems (Lim, 2006, 2007; Lim & Hang, 2003). His metaphor suggests that considerations about optimum culture in institutions parallel those of optimum environments for growth in gardens. Both entities are dependent on the larger ecology within which they are embedded. Therefore, one needs to consider what takes place within each system as well as what takes place without. Lim (2006, 2007; Lim & Hang, 2003) applied Cole's work extensively to technological integration in schools and suggests that insight into technological use in schools requires an understanding of how cultures at various levels of

context are intertwined. Using the classroom as the first level activity system, Lim and Hang (2003) go on to consider the classroom as being embodied in the school which is in turn situated in a broader governmental technological division which is in itself situated within the broader-levelled education ministry in a series of concentric circles.

Albeit similar to Lim's application of Cole's metaphor to technological integration, Bronfenbrenner's (1979, 1994) ecological theory provides another, but more methodical and nuanced lens with which to uncover the different layers of contexts surrounding that of digital portfolio integration in teacher education. There are five types of environmental contexts in Bronfenbrenner's (1979, 1994) ecological systems theory. They are the (1) microsystem, (2) mesosystem, (3) exosystem, (4) macrosystem, and (5) chronosystem. The five levels are represented by a series of concentric circles that conjure the image of the layers of an onion. These levels range from the close proximal settings within which individuals function directly to larger and wider distal settings that influence the individual indirectly. Proximal settings are embedded within the comparatively wider and more distal settings. Stanger (2011) provides an adapted illustration of Bronfenbrenner's (1979, 1994) theory as represented in Figure 2. When used to complement CHAT, the successive circles of the Bronfenbrenner's concentric model can be understood to represent activity systems in broader contexts (cf., Lim, 2006, 2007; Lim & Hang, 2003).

Rogoff (1995) in conceptualising her planes of analysis argues that the subject of an activity is the one that identifies the bounded systems of activity. In an activity systems analysis, the unit of analysis remains the object-oriented activity that is under investigation, but the subject can be an individual, a group of individuals, or an organisation (Yamagata-Lynch, 2010). To prevent CHAT scholars from being overwhelmed in the analytic process, Rogoff suggests the notion of zooming in into one plane of analysis at any one point in time. Other planes may be blurred out momentarily through identifying salient features which though are not in focus, are nevertheless essential and relevant to help further appreciate the zoomed-in plane of analysis (Rogoff, 1995, 1998). Thus, it is important to make evident, which plane is the point of focus at any point in time (Yamagata-Lynch, 2010). In other words, it is important to specify which concentric circle or which level of context is being focused upon at any point in time.

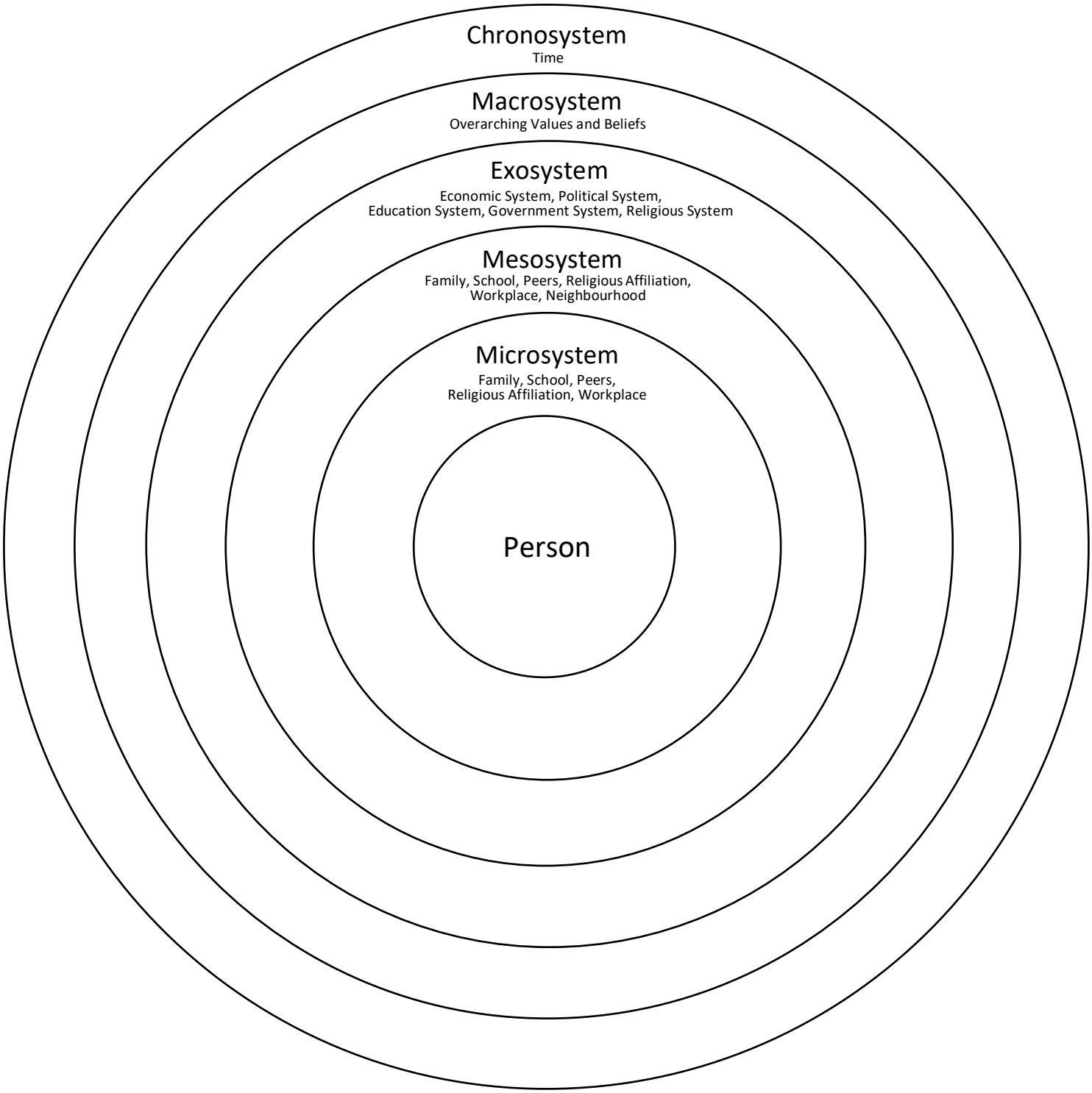

Figure 2. An adapted illustration of Bronfenbrenner's Ecological Theory (Stanger, 2011, p. 169).

Taking the digital-portfolio construction activity by the individual as the first level activity system, we understand from a CHAT perspective that this activity system is then embodied within different levels of activity systems like layers of an onion. These different levels of the activity system as referred to in CHAT, can then be systematically deconstructed and specified using Bronfenbrenner's theory as a guide. These other activity systems include microsystems which may involve the teacher education classroom, the teacher education programme, schools; exosystems such as the economic, political, government and educational systems within which the microsystems are situated, macrosystems and chronosystems such as the culture of the country and her history. These form the subsequent layers of the activity system. These activity systems can be represented in the diagram below (see Figure 3).

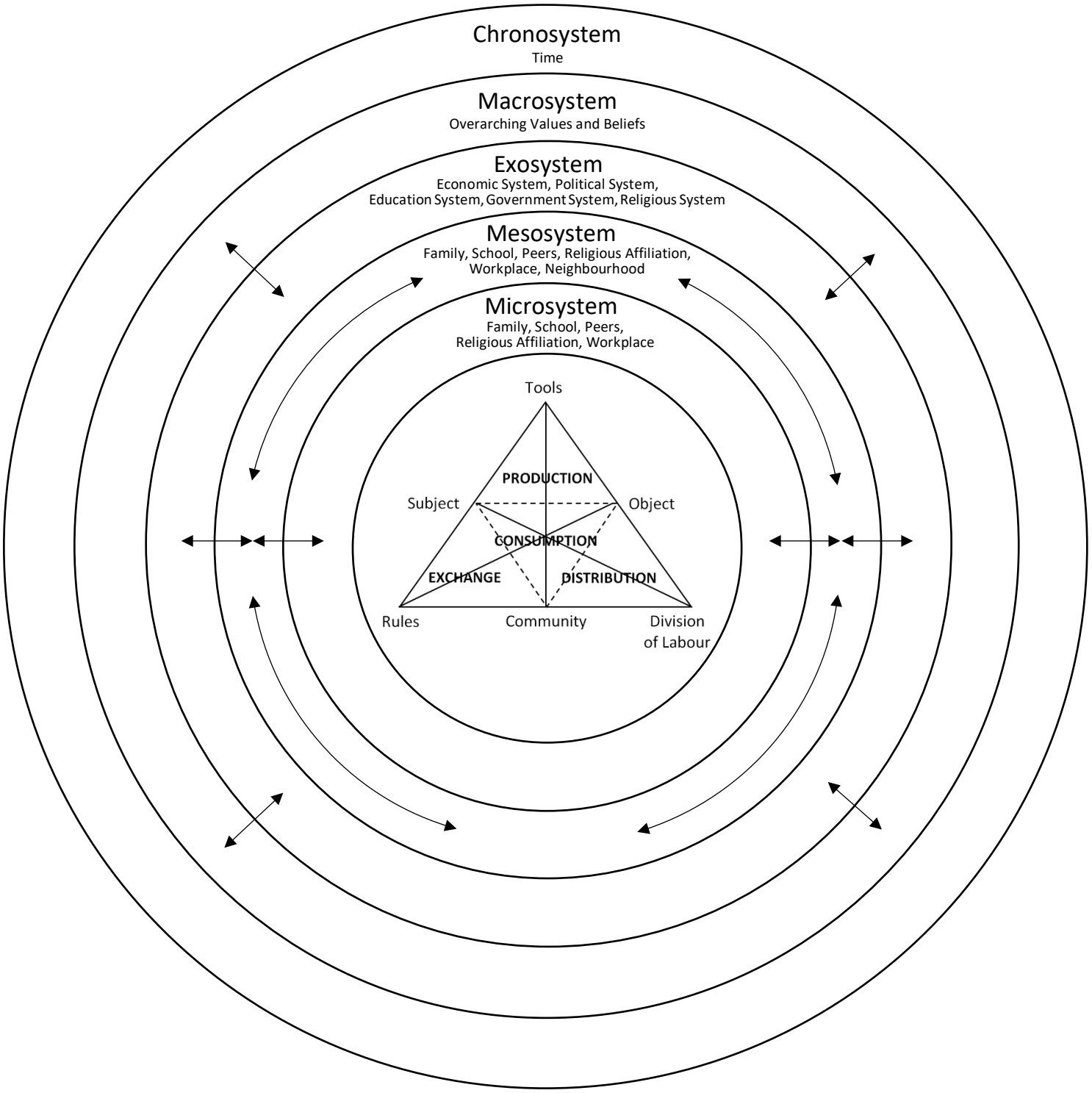
Chronosystem
Time
Macrosystem
Overarching Values and Beliefs
Exosystem
Economic System, Political System,
Education System, Government System, Religious System
Mesosystem
Family, School, Peers, Religious Affiliation,
Workplace, Neighbourhood
Microsystem
Family, School, Peers,
Religious Affiliation, Workplace
Tools
PRODUCTION
Subject
Object
CONSUMPTION
EXCHANGE
DISTRIBUTION
Rules
Community
Division
of Labour

Figure 3. An Activity System within the broader Sociocultural-historical Context: Integrating CHAT and Bronfenbrenner's Ecological Systems Theory

Considerations for the Effective Integration of Digital Portfolios into Teacher Education: An Activity Theoretical Perspective

While CHAT is not a prescriptive theory (Jonassen & Rohrer-Murphy, 1999), the descriptions guided by CHAT allow us to see the problems in its entirety and to address each specifically without losing sight of the whole. CHAT researchers (e.g., Jonassen & Rohrer-Murphy, 1999; Lim, 2006, 2007; Lim & Hang, 2003; Yamagata-Lynch, 2010) provide a set of guidelines for how to apply CHAT as a framework to ascertain the specific components within each focal level of activity system that need to be considered. For example, Jonassen and Rohrer-Murphy (1999) identify the process for applying activity theory to the design of constructivist learning environments. They identify six major steps of considerations for analysing an activity system. The six major steps include (i) first clarifying the purpose of the activity system; (ii) analyzing the activity system; (iii) analyzing the activity structure; (iv) analyzing the mediators; (v) analyzing the context; and (vi) analyzing the activity system dynamics. Each of these major steps consist of sub-considerations and sample questions that can be asked as one thinks about how best to successfully design learning environments. Lim and Hang (2003) provide a similar activity theoretical analysis in relation to the incorporation of ICT use in schools. Their insights although applicable and relevant, need to be adapted for specific considerations of critical factors necessary for the successful integration of digital portfolios into teacher education programmes.

Following these researchers and adapting their framework for our use, we breakdown each major analytic step into sub-steps, and for each sub-step in the process, we apply and modify the sample questions arising from these researchers' work to analyse different levels of the activity system for our purpose of integrating digital portfolios into teacher education successfully. A better understanding of the interconnections and contradictions of the activity systems at various levels will shed more light on the digital portfolio integration process.

In this paper, we apply and adapt Jonassen and Rohrer-Murphy's (1999) framework to our specific context and issue of concern – the integration of digital portfolios into teacher education. Following Jonassen and Rohrer-Murphy's analytical steps and considerations, Table 1 describes

the kinds of questions and issues that need to be addressed in relation to digital portfolio integration within each context. It allows us to identify the congruence and the tensions within each activity both within and across activity systems. The questions and issues raised will shift based on the evolving awareness of what takes place within each of the activity systems (Jonassen & Rohrer-Murphy, 1999; Lim & Hang, 2003) as well as be dependent on the focal plane of analysis adopted by the researcher (e.g., Rogoff, 1995, 1998). The object of interest should be continually refocused so as to provide different views as well as to further the activity of digital portfolio integration as much as possible (cf., Kuutti, 1991; Rogoff, 1995, 1998).

Table 1: Applying and Adapting Jonassen & Rohrer-Murphy's (1999) Framework of Activity Theoretical Analysis to the Issue of Digital Portfolio Integration

	Step 1: Clarify the purpose(s) of the activity system and outcomes	
1.1	Understand the relevant context(s) within which the construction and integration of the digital portfolio occurs	What are the typical problems? What are the communications surrounding the construction and integration of the digital portfolio? What participants or groups are involved in the successful completion and integration of the digital portfolio? Where and when do the problems occur? What are the broader contexts beyond the individual activity of portfolio construction? What are the different layers of contexts within which the activity occurs? What are the micro-, meso-, exo-, macro- and chrono- systems at work?
1.2	Understand the subject, his or her motivations and interpretations of perceived contradictions in the system	Generate a comprehensive list of subject-driven motives and goals for each of the groups involved that might drive the activity. Who are the individuals involved in the activity system? What are their subject-driven motives and goals that might drive the activity? Who is/are the subject(s) in focus?
1.3	Identify the unit of analysis	Zoom in and ask: What is the unit of analysis and the activity system that is in focus? Zoom out and identify the outer layers of the contexts that embody the activity of integrating digital portfolios.
	Step 2: Analyse the Focal Activity System	
2.1	Define the subject in the focal activity system	Who is/are the subject(s) in the focal activity system? What are their roles? What is the expected outcome of constructing the digital portfolio? What criteria will be used by the community to evaluate the utility of the digital portfolio? What perceived rewards await the subject if or when he/she accomplishes the digital portfolio? What are the goals-motives of the subject? What are the goals-motives of the activity of digital portfolio integration and how are they related to goals-motives of others and society? Is there a congruence in the goals-motives? What is the division of labour within the activity system? What are the implied rules or roles for each member of the community?
2.2	Define the relevant community/communities	Who are the participants in the focal activity system? Who are the relevant communities within each layer of the contexts? How do other communities in which subjects are involved view the digital portfolios? Do they value the digital portfolios and its goals? What perceived rewards await the student teacher if or when he/she accomplishes the digital portfolio?
2.3	Define the object and outcome	What are the purposes and goals of the activity of constructing and integrating the digital portfolio? What are the expected outcomes of the activity of constructing and integrating the digital portfolio? What should the end product look like? How will the quality of the outcome be evaluated? Who will be evaluating the digital portfolio? How will completing the digital portfolio move the subject towards

		fulfilling the intentions of the community? What are the essential requirements of the community which are critical to achieving the desired objects and the outcomes? Which are of greater weight and of greater import and should be prioritized? Which are urgent and important? Does digital portfolio feature in any of these?
	Step 3: Analyse the Activity Structure	
3.1	Define the activity itself	How is work for the digital portfolio being done in practice? What historical phases have there been on the digital portfolio, its construction and integration? What was the nature of the changes to the digital portfolio that occurred in different historical phases? What are the norms, rules, and procedures for the activity of digital portfolio construction and integration? What are the goals of the digital portfolio and how are they related to other concurrent goals of the activity systems? What are the contradictions, as perceived from the standpoints of all relevant subjects and communities that drive the construction and integration of the digital portfolio?
	Step 4: Analyse Mediators	
4.1	Tool mediators and mediation	What technological, non-technological and cognitive tools might be used in digital portfolio construction? What are the technological, non-technological and cognitive tools used to construct and integrate the digital portfolio in different settings? How do the different tools compare to one another? How do the different tools contribute to the objectives and outcomes? How readily available are those tools to participants and in relative relation to one another? How have the tools changed over time? How might participants use these tools? Is their use flexible, or is adherence required?
4.2	Rule/Norms mediators and mediation	What are the expectations of the subject? Who sets those expectations? What formal or informal rules, norms or assumptions guide the digital portfolio activities in which people engage? What formal or informal rules, norms or assumptions guide the process of digital portfolio construction and integration? How might these rules have evolved? Are the rules task-specific? How widely understood and enacted are these rules?
4.3	Division of Labour/Roles mediators and mediation	What are the roles of the subjects? Who traditionally has assumed the various roles? Are the roles flexible? Or mandated?
	Step 5: Analyse Activity System Dynamics	
5.1	What are the interrelationships that exist within the components of the digital portfolio activity system?	What are the dynamics that exist between the components of the digital portfolio activity system? How do the subjects perceive the goals of the digital portfolio, particularly as compared to their own successes and their perceptions of what has led to those successes? Are there contradictions or inconsistencies within the needs of the subject and the community and the goals of the digital portfolio activities?
5.2	Understand the subject, his or her motivations and interpretations of perceived contradictions in the digital portfolio activity system	What aspects of the student teacher might contribute to the dynamics of the situation? What are all the interconnecting activity systems? Is there alignment between and within each component of the activity systems?

(Adapted from Jonassen and Rohrer-Murphy, 1999)

Operationalising the Theoretical Framework: An Illustrative Example of the Integration of Digital Portfolios in Teacher Education in Singapore

In order to exemplify how the theoretical framework can be operationalized, this paper draws upon the case of digital portfolios as it is used in teacher education in Singapore.

EXCEL (a pseudonym) is an educational institution in Singapore that provides teacher education. Given increasing complexities and demands associated with teaching, teacher educators and faculty at EXCEL are aware that teacher education needs to demonstrate coherence and integration among courses and programmes, demonstrate strong theory-practice connections, ensure good partnerships with schools and nurture the personhood of the teacher. To address these issues, the use of the digital portfolio was introduced into the initial teacher education programme.

A digital portfolio system, conceptualized to be developmental in nature, was designed and conceptualized. It was conceptualised as 'a tool or a method' (Granberg, 2010, p. 313) or a pedagogical device (Bernstein, 2000) which had as one of its intentions, to document the learning experiences and the growth of the student teacher at EXCEL. The digital portfolio at EXCEL was operationally defined as an electronic collection of authentic and diverse evidence of a student teacher's learning and achievement over time, on which he/she has reflected and designed for personal development, as well as for presentation to audiences for specific purposes. Google Sites – the free open-source application, was adopted as a platform to host student teachers' portfolios (Author – Removed for Blind Review).

The digital portfolio at EXCEL was conceived to be developmental in nature and did not constitute student teacher assessment. As such, it was enacted as a tool that supported current requirements of the program. Nonetheless, a number of strategies were employed to buttress the integration of digital portfolios into the initial teacher preparation program. Firstly, student teachers were required to participate in a digital portfolio module which focused on application issues and getting students to integrate their learning. Secondly, tutors were encouraged to support integration efforts by using the digital portfolio for their course assignments. Thirdly, student teachers were encouraged to upload artefacts onto their digital portfolio and to share them with peers and tutors for feedback purposes. Fourthly, milestone checks were implemented. To ensure the use of the digital portfolio, student teachers were required to make a presentation to key personnel in school both before and after their teaching practicum using their digital portfolio. In many ways, this was a presentation that emphasised the showcase purpose of the portfolios. These formalised sharing

sessions provided an opportunity for the student teachers to talk about their learning experiences and to demonstrate their attainment of competencies.

However, despite the purported benefits of the digital portfolio, (Author – Removed for Blind Review) note that the division in the teacher education framework at EXCEL and gaps between theory and practice prevented student teachers at EXCEL from using the portfolios beyond the collative function and beyond superficial reflections on learning and teaching. Student teachers use the tool as a repository more than a thinking tool. The lack of guidance in helping student teachers to make sense of their role and the lack in follow-up use of the digital portfolio upon graduation and entry into the professional environment further exacerbated this issue. Student teachers highlighted the tensions involved in the multipurpose digital portfolio, the role of the digital portfolio in the larger education system, misalignment in expectations and disparities in expected versus enacted roles (Author – Removed for Blind Review).

In Singapore, the activity system of the digital portfolios spans across multiple contexts of which teacher education is but one, albeit the focus of this paper. It includes the individual student teacher, the teacher education classroom and the teacher education programme at EXCEL, schools which partner with the EXCEL for student teachers' teaching practicum, the Ministry of Education, Singapore, the economic and political landscape, and the culture and history of Singapore (see Figure 4). To enhance this current digital portfolio system and implementation from an activity systems perspective, it is important to ask the following questions and address the resultant issues. The focal activity is the integration of digital portfolios from an institutional or administrative perspective, with the understanding that this would be affected by other activity systems within which it is embodied or which it embodies.

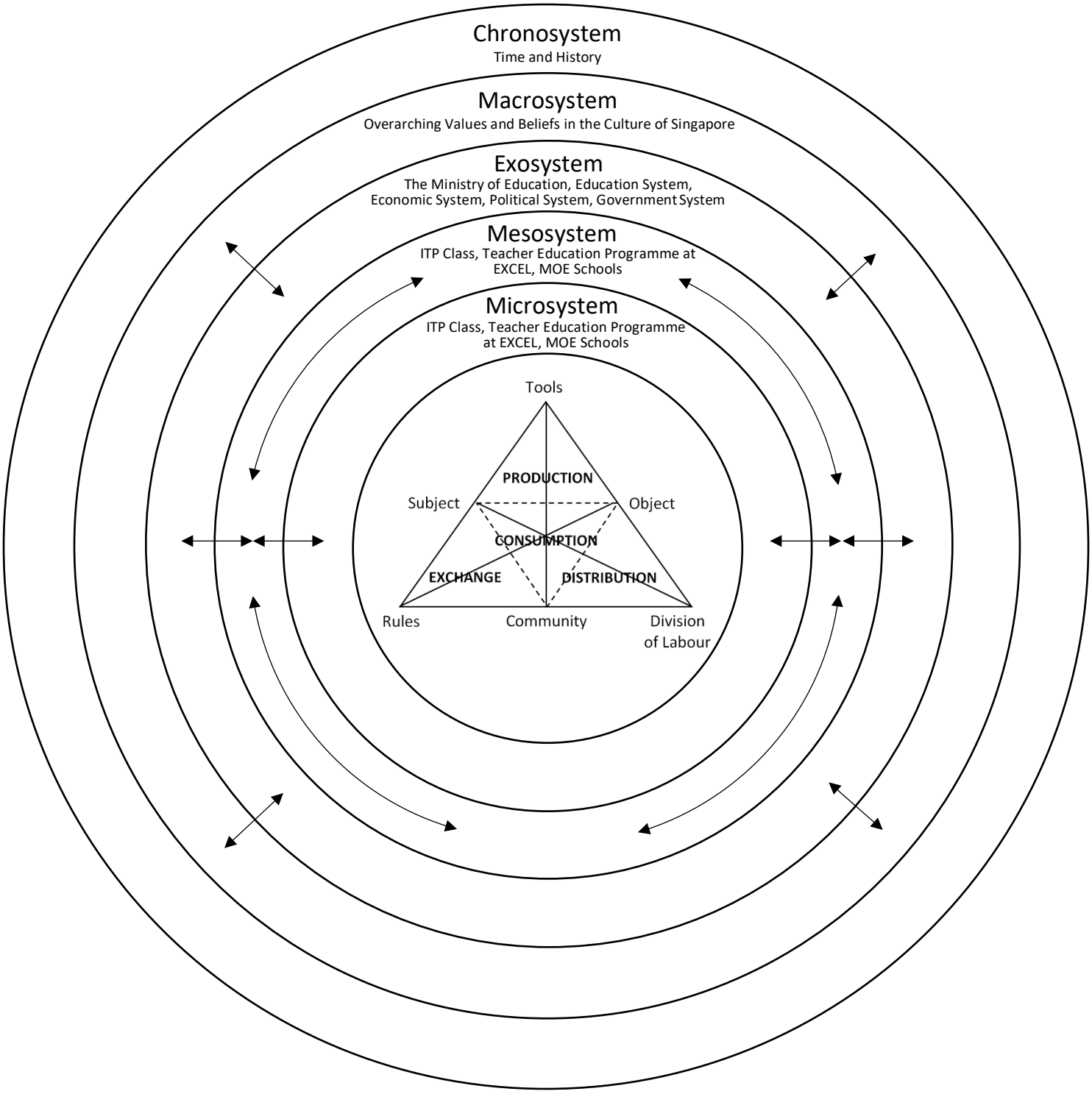

Figure 4. The Digital Portfolio Activity System in Singapore

Table 2 describes the kinds of questions and issues that need to be addressed in relation to the following activity structures in Singapore - the individual, the teacher education classroom, the teacher education programme, schools, the Ministry of Education and the wider educational system. To ensure a manageable scope for this paper, we will not be considering the broader macro- and chrono-system factors.

Table 2: Layers in the Digital Portfolio Activity System in Singapore

Subject Who is/are the focal subject(s) in the digital portfolio activity system?	
The Individual	Individual Student Teacher
Microsystem: **ITP Courses and Classes**	Faculty Peers
Microsystem: **Teacher Education Programme**	Teacher Education Administrators
Microsystem: **Ministry of Education (MOE) Schools**	School Personnel (School leaders, mentors, cooperating teachers)
Exosystem: **The Ministry of Education and the Wider Educational System**	Government and Ministerial leaders

Outcome What are the expected outcomes of the activity of constructing and integrating the digital portfolio? What should the end-product look like? How will the quality of the outcome be evaluated? Who will be evaluating the digital portfolio? How will completing the digital portfolio move the subject towards fulfilling the intentions of the community?	
The Individual	Reflective practitioner Certified beginning teacher Completed digital portfolio that can be further built on across career span
Microsystem: **ITP Courses and Classes**	Reflective practitioner Knowledge, skills, attitudes, values required for a beginning teacher Expected course and programme outcomes, curricular goals
Microsystem: **Teacher Education Programme**	Possess the know-how, professional attitudes and qualifications to be a teacher. For example, to be a reflective practitioner, attain the competencies stated in teacher education models, such as the Values, Skills and Knowledge model and the Graduand Teacher Competencies. Ability to make theory-practice connections. Able to aggregate and integrate their learning. Graduate from teacher education programme.

Microsystem: **Ministry of Education (MOE) Schools**	Reflective practitioners Assessment of practicum and teacher inquiry course Recruitment determining candidates' suitability for teaching in schools Beginning Teachers Competencies framed by the Singapore Teaching Practice, and ETHOS for example.
Exosystem: **The Ministry of Education and the Wider Educational System**	Policies and masterplan for the educational system (e.g., enable teachers to help students achieve the desired outcomes of education; enable teachers to attain the standards and the facets of the teaching profession, the vision of the teaching fraternity)

Object

What are the purposes and goals of the activity of constructing and integrating the digital portfolio? What are the essential requirements of the community which are critical to achieving the desired objects and the outcomes? Which are of greater weight and importance and should be prioritized? Does the digital portfolio feature in any of these?

The Individual	What are the individual student teacher's motives and goals? (e.g., reflection, acquiring skills, complete graded assignments and pass the course, graduate, obtain the professional qualifications to be a teacher) Do digital portfolios feature in any of these? How can the digital portfolio help the student teacher to attain their goals?
Microsystem: **ITP Courses and Classes**	What are the objectives of teacher education classrooms? Does the digital portfolio feature or play a potential role in any of these objectives? Are the objectives related to the larger teacher education programme? Are there any objectives held in the classrooms that may contradict the digital portfolio initiative? Examples of these may include lesson and curricular goals, and assessment.
Microsystem: **Teacher Education Programme**	Learning, Showcase, Certification Reflection Archiving Tool for thinking Integration Aggregation Theory-Practice links
Microsystem: **Ministry of Education (MOE) Schools**	What are the objectives of schools and their personnel? These may include assessing and determining if the student teacher can write lesson plans and execute their lessons well; supporting the student teacher with the passing of their teaching practicum. Mentoring and guiding the student teacher in teaching. Assessing student teachers and determining if the student teachers will potentially make a contribution to the school and to their students' learning and to the education fraternity. Does the digital portfolio feature in any of these objectives? Do the objectives of the school build on the objectives of digital portfolios as used in teacher education? Does the digital portfolio potentially have a role to play in any of the school's objectives? Are the objectives related to the larger MOE system? Are there any objectives held by the school that may contradict the digital portfolio initiative?
Exosystem: **The Ministry of Education and the Wider Educational System**	What are the overall objectives of MOE? What are the objectives within the various departments of MOE? Does the digital portfolio feature in any of these objectives? Does the digital portfolio potentially have a role to play in any of these objectives? For example, in employment, recruitment, professional development.

Tools

What technological, non-technological and cognitive tools might be used in digital portfolio construction? What are the technological, non-technological and cognitive tools used to construct and integrate the digital portfolio in different settings? How do the different tools compare to one another? How do the different tools contribute to the objectives and outcomes? How readily available are those tools to participants and in relative relation to one another? How have the tools changed over time? How might participants use these tools? Is their use flexible, or is adherence required?

The Individual	May include ICT and non-ICT tools such as Googlesites, other preferred portfolio platforms, hardcopy portfolios, student teacher ICT skills, metacognition.
Microsystem: ITP Courses and Classes	May include ICT and non-ICT tools such as Googlesites, other preferred portfolio platforms, other ICT platforms, paper and pencil tasks, other pedagogical tools, student teacher and faculties' ICT skills.
Microsystem: Teacher Education Programme	Primarily the digital portfolio via the Googlesites platform, but also curriculum, policies, pedagogies, other initiatives, other available ICT tools and platforms.
Microsystem: Ministry of Education (MOE) Schools	Other open source ICT and portfolio platforms and tools Other MOE ICT platforms and tools Hardcopies Does the digital portfolio feature in any of these?
Exosystem: The Ministry of Education and the Wider Educational System	Tools for employment, recruitment, remuneration, promotion and performance management (e.g., the Enhanced Performance Management System or EPMS; School Cockpit), career tracks, professional development Does the digital portfolio feature in any of these?

Community

Who are the participants in the focal activity system? Who are the relevant communities within each layer of the contexts? How do other communities in which subjects are involved view the digital portfolios? Do they value the digital portfolios and its goals? What perceived rewards await the student teacher if or when he/she accomplishes the construction of the digital portfolio?

The Individual	The focal subject is the individual student teacher. Other participants include other student teachers, teaching faculty, practicum supervisors, school leaders (e.g., Principals) and mentoring teachers, administrators of the teacher education programme, and the MOE.
Microsystem: ITP Courses and Classes	The focal subject is the teaching faculty tutoring the class. Other participants include other student teachers, other teaching faculty, members of the faculty's department, administrators of the teacher education programme, practicum supervisors, school leaders (e.g., Principals), mentoring teachers and the MOE.
Microsystem: Teacher Education Programme	The focal subjects are the administrators of the teacher education programme. Other participants include student teachers, teaching faculty, practicum supervisors, school leaders (e.g., Principals), mentoring teachers and the MOE.
Microsystem: Ministry of Education (MOE) Schools	The focal subjects are the school personnel, mentors and school leaders. Other participants include other student teachers at the school, practicum supervisors, administrators of the teacher education programme, and the MOE.
Exosystem: The Ministry of Education and the Wider Educational System	The focal subjects would be the Ministry of Education (e.g., the technological and professional development branches). Other participants include schools, EXCEL, other educational institutions and other government ministries

Rules/Norms

What are the expectations of the subject? Who sets those expectations?
What formal or informal rules, norms or assumptions guide the digital portfolio activities in which people engage? What formal or informal rules, norms or assumptions guide the process of digital portfolio construction and integration? How might these rules have evolved? Are the rules task-specific? How widely understood and enacted are these rules?

The Individual	Are there expectations and requirements to use digital portfolios? How should digital portfolios be used? What should be included in it? What are the expectations of the various communities in terms of the use of digital portfolios? Are these consistent? Which has greater weight or consequences?
Microsystem: **ITP Courses and Classes**	Are there expectations and requirements to use digital portfolios in teaching and assessment? Are these mandatory? Are digital portfolios required for student teachers to pass the programme?
Microsystem: **Teacher Education Programme**	In EXCEL, there is an expectation to use the GoogleSites digital portfolio. But this is not mandatory. The digital portfolio is not assessed and does not contribute to examination grades nor the passing of the teacher education programme. Do faculty, student teachers and schools know about the expectations on the use of the digital portfolio? To what extent do they enact it? What are the courses requiring the use of digital portfolios?
Microsystem: **Ministry of Education (MOE) Schools**	In schools, it is expected that student teachers use the GoogleSites digital portfolio. However, this is not part of the assessment for teaching practicum. Do school leaders, school mentors and cooperating teachers expect digital portfolios to be used? Is there a requirement to use digital portfolios in the schools? Are there any initiatives or incentives in schools requiring the use of the digital portfolio (for example for recruitment, professional development and future promotional purposes)?
Exosystem: **The Ministry of Education and the Wider Educational System**	Is there a requirement to use digital portfolios in MOE for employment, professional development, promotional, or human resource purposes? Are there any initiatives in MOE/HQ requiring the use of the digital portfolio? Is the digital portfolio in line with or part of the technological platforms rolled out by the technology division?

Division of Labour/Roles

What are the roles of the subjects?
Who traditionally has assumed the various roles?
Are the roles flexible? Or mandated?

The Individual	What is the role of the student teacher? What are the roles of the other participants in the community? Student teachers were to actively build and maintain and use their digital portfolio throughout their time at EXCEL. They were encouraged to share their digital portfolio with their peers for feedback. Is the role of the student teacher and the other participants articulated and clarified? To what extent are they enacted? Dynamics and power relations between MOE, schools, and the teacher education institution as well as role division between administrators, faculty, school personnel, the peers of the student teacher and the student teacher himself/herself

Microsystem: **ITP Courses and Classes**	What is the role of the faculty in the use of the digital portfolio? What is the role of the other student teachers in the classroom in terms of the digital portfolio? In EXCEL, the course tutors are to integrate digital portfolio into their teaching and assignments. Practicum supervisors were to check on student teachers digital portfolios. Who is in-charge of monitoring the use of the digital portfolio by the student teachers and with the tutors? Dynamics and power relations between MOE, schools, and the teacher education institution as well as role division between administrators, faculty, school personnel, and the student teachers
Microsystem: **Teacher Education Programme**	Who is in-charge of monitoring/encouraging the use of the digital portfolio? With the student teachers and with the tutors and practicum supervisors? In EXCEL, it is an initiative by teacher education programme administrators. The initiative garnered support from some tutors and practicum supervisors but not all. Are these shared responsibilities? Is there buy-in? Is it perceived to be top-down? Dynamics and power relations between MOE, schools, teacher education administrators, faculty and the student teachers
Microsystem: **Ministry of Education (MOE) Schools**	Are there requirements for digital portfolio use by school leaders, cooperating teachers and school mentors? Who monitors its use? Dynamics and power relations between MOE, schools, teacher education administrators, faculty and the student teachers School leaders and mentors did not monitor the use of the digital portfolio as hoped
Exosystem: **The Ministry of Education and the Wider Educational System**	Can MOE personnel support the digital portfolio in any way? Dynamics and power relations between MOE, schools, teacher education administrators, faculty and the student teachers

Recommendations

From a CHAT perspective, at least as applied to the context of teacher education in Singapore, the following key considerations are suggested:

1. Even though the focus is on the integration of the digital portfolio into teacher education, one cannot deny the fact that teacher education does not exist on its own. It is embodied within and embodies other interrelated activity systems which have an impact on initiatives in teacher education.
2. Digital portfolios should contribute to the final outcomes in teacher education and the objects of the different levels of the digital portfolio activity system need to be aligned.
3. The platform needs to be evaluated in terms of usability, scalability and relevance.

4. Expectations, standards and benchmarks should be the same both in policy and practice. Perceived, expected and actual roles of the participants in the entire digital portfolio activity system should be congruent.

Conclusions

CHAT suggests that resolving the tensions and contradictions would result in a successful integration of the digital portfolio into teacher education and opens possibilities for a more sophisticated form of digital portfolio integration. By using CHAT to systematically analyze and guide the integration of digital portfolios into teacher education, areas that require resolution are highlighted, enabling digital portfolios to be more successfully integrated across contexts. A position is not taken here as to how policy makers and administrators should weigh the different considerations. As such, the framework offers merely a set of considerations, and is only minimally prescriptive.

This article has described the steps with which CHAT may be used as a framework to guide the integration of digital portfolios into teacher education, using Singapore as an example. Applying CHAT to achieve the purpose of integrating digital portfolios involves examining different factors in the activity structures; the outcome, the object, the tools, rules, roles, and the myriad layers of social context in which it occurs. Although there have been successes (Author – Removed for Blind Review), further validation of these steps for a systemic analysis of digital portfolios in teacher education is required.

Statements on open data, ethics and conflict of interest

The author declares that there is no conflict of interest in the work reported herein. Pseudonyms have been used to protect the identity of the institution.

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