ỨNG DỤNG PHƯƠNG PHÁP PHÂN TÍCH CHỦ ĐỀ VÀO PHÂN TÍCH HỘI THOẠI VỀ THIẾT KẾ BÀI GIẢNG CỦA GIÁO SINH

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Phân tích chủ đề là một phương pháp phân tích số liệu định tính phổ biến gồm sáu bước; tuy nhiên, rất ít nghiên cứu áp dụng phương pháp này mô tả từng bước cũng như giải thích rõ ràng quy trình phân tích số liệu để cả quá trình có thể được ứng dụng và nhân rộng, đặc biệt cho những người mới bắt đầu làm nghiên cứu. Bài báo này mô tả chi tiết phương pháp áp dụng Phân tích chủ đề vào phân tích hội thoại về thiết kế bài giảng ứng dụng công nghệ của các nhóm giáo sinh. Các tiêu chí nghiên cứu định tính cũng được đan xen vào cả quá trình phân tích số liệu để đảm bảo độ giá trị của kết quả nghiên cứu. Ngoài ra, phương thức kiểm tra chéo kết quả phân tích dữ liệu cũng được tiến hành hai lần nhằm đảm bảo độ tin cậy và tính khách quan của kết quả nghiên cứu. Quy trình phân tích nội dung được chi tiết hóa trong bài báo này góp phần bổ sung thêm kiến thức về phân tích số liệu định tính.

Từ khóa: *phương pháp phân tích chủ đề, độ tín nhiệm, kiểm tra chéo độ tin cậy, phân tích số liệu định tính, thảo luận thiết kế nhóm.*

Thematic analysis is a popular six-phased approach to analysing qualitative data; however, very few studies adopting this approach have explicitly demonstrated step-by-step and explained the whole data analysis process so that it could be replicated, especially by first-time researchers. The purpose of this paper is to offer a detailed description of how thematic analysis approach was adopted to analyse pre-service teachers' design talks while designing their technology-enhanced lessons. At the same time, trustworthiness criteria were interwoven throughout the procedures to maintain the validity of the findings. Also, intercoder reliability checks were conducted twice to guarantee the reliability and objectivity of the findings. The detailed procedures provided in this paper have added to the existing knowledge of qualitative data analysis.

Keywords: *thematic analysis, trustworthiness, inter-coder reliability, qualitative data analysis, design talks.*

THEMATIC ANALYSIS OF PRE-SERVICE TEACHERS' DESIGN TALKS

1. Introduction

This paper focuses on detailing qualitative data analysis procedures adopting thematic analysis approach initiated by Braun and Clarke (2006). This approach is defined as "a method for identifying, analysing and reporting patterns (themes) within data" (Braun & Clarke, 2006, p. 79). Apparently, scholars choose it because it represents a generic, foundational method across qualitative approaches (Nowell et al., 2017), is

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widely used, theoretically flexible and can detail the description of data in a rich yet complex way, which then allows for interpretations of various aspects of the researched topic (Braun & Clarke, 2006).

Conducting thematic analysis involves looking for patterns of meaning within data, classification of data extracts, and constant comparison between the data being produced with the original dataset (Braun & Clarke, 2006). Therefore, it is helpful in the examination of various participants' perspectives, exploration of similarities and discrepancies, and the attainment of unexpected insight (Braun & Clarke, 2006; Nowell et al., 2017).

Thematic analysis has been used in studies in various disciplines, particularly social sciences and humanities (Belotto, 2018; Braun & Clarke, 2012; Clarke & Braun, 2018; Roberts et al., 2019). However, hardly any qualitative studies have been found to describe the whole process of coding and enabling themes, or patterns, to surface although it has been claimed that a well-described coding process that follows six phases in the thematic approach will allow the method transferability and support the rigor and credibility of the approach (Roberts et al., 2019).

In parallel with adopting the thematic analysis, qualitative researchers have incorporated the concept of trustworthiness into analysing qualitative data in an attempt to make qualitative findings more valid and the data analysis approaches easier to follow (Maguire & Delahunt, 2017; Nowell et al., 2017). The concept of trustworthiness was reflected through data analysing procedures that had a logical and clear flow with detailed and systematic documentation. It was also reflected through critical reflections, thoughtful explanations, triangulation and continuous engagement with the data (for more information about all the criteria, refer to Nowell et al. (2017). In this study, the aforementioned trustworthiness criteria were interlaced throughout a description of how the researcher attempted to carry out a trustworthy thematic analysis. This incorporation of trustworthiness with thematic analysis has been rarely specifically described in the literature, either.

The case-study where this thematic analysis approach was adopted was carried out over two cycles with each being Session 1 of two consecutive academic years within a unit called Information Communication and Technology in Education at a university in Australia. Data was collected from 18 pre-service teachers who were Education students learning to be teachers, nine in each cycle. These participants worked in groups of three to design collaborative technology-enhanced modules. Their in-class design talks and Facebook Messenger chats were recorded while the design activities were occurring in groups over five weeks in Cycle 1 (C1) and six weeks in Cycle 2 (C2). All the data were then screened and analysed in Nvivo 11, a well-known software package for analysing qualitative data.

This set of data was analysed to answer the research question: What elements do pre-service teachers focus upon while designing their collaborative technology-enhanced modules? The usage of thematic analysis was of great help in search for patterns within the pre-service teacher groups' design processes to answer the research question. This paper aims at providing a detailed description of the whole trustworthy thematic analysis-based data analysis process in order to answer the research question For Findings and other related issues, refer to Nguyen (2020).

2. The step-by-step approach to conducting trustworthy thematic analysis

Table 1 highlights how the researcher of this study made an effort to maintain the trustworthiness during each phase of thematic analysis. The table was adapted from Nowell et al. 's analysis (2017, p. 4).

Table 1. Establishing trustworthiness during each phase of thematic analysis

Phases of thematic analysis	Means of establishing trustworthiness
Phase 1: Familiarising yourself with your data	Prolonging engagement with data
	Triangulating different data collection modes
	Starting a coding manual
	Documenting thoughts about potential codes
	Storing and organising data in NVivo
	Setting up a parent node system in NVivo
Phase 2: Coding	Developing a coding framework
	Reflexive journaling
	Using a coding framework
	Documentation of code generation
Phase 3: Searching for themes	Detailed notes about development and hierarchies of concepts and themes
	Diagramming to make sense of theme connections
Phase 4: Reviewing themes	Returning to original framework for comparing
	Revisiting codes and sub-codes
Phase 5: Defining and naming themes	Documentation of theme naming
	Documentation of meetings regarding naming themes
Phase 6: Producing the report	Describing process of coding and analysis in sufficient detail
	Referring to all reflective journaling
	Reporting on rationales for different choices and decisions

This method is actually not as linear and six-phased as it appears because there involved a constant moving back and forth between phases and reflections developed over time in the whole process. The next section will detail the whole six-phased trustworthy thematic analysis procedures conducted by the researcher using NVivo 11.

2.1. Familiarising with data

In addition to storing data in safe places and organising them neatly, this phase necessitated the researcher's self-immersion in the data. Through immersion in the data, the researcher became familiar with all aspects of the data, made initial sense of the depth and breadth of the content, and quickly shaped initial ideas and identification of possible patterns in accordance with Braun and Clarke (2006) and Nowell et al. (2017). This was especially helpful for the researcher because she had become familiar with this type of data in the pilot study and could quickly feel intimately engaged with it. In fact, a brief summary of each participating team's weekly main activities was made during this phase, providing a general picture of the design process patterns, which was helpful for more analyses enabling more specific patterns to surface in the next steps. There were also some exciting moments when the researcher identified potential themes which might be different from the existing pre-determined ones.

One important move at this step was to decide on segments of data to which codes could be assigned. A segment (also called a text segment) is a data extract (which can be phrases, sentences, or paragraphs) that carries a unit of meaning relevant to the phenomenon under investigation (Braun & Clarke, 2006; Creswell, 2015). For the in-class design conversations and Facebook instant messages, sentences were chosen as units of analysis due to their characteristics as fine-grained units, providing greater distributions of codes, enabling the emergence of patterns of collaborative design and issues related to it (Bower, 2009). Also, breaking down transcribed textual data by sentence showed that syntactical differences rather than semantic differences were used to identify the textual units and therefore introducing bias to the data prior to coding could be avoided (Koh & Chai, 2016).

The chats in Facebook Messenger were all instant messages sent among the group chat members, who were also the participants; therefore, the original texts' syntax had to be considered. In this case, to separate the sentences, the researcher either based it on the punctuation (stops, question marks, exclamation marks) used by the participants, or applied an "invisible" dividing line where the participants typed a big chunk of text without any punctuation marks signalling the end of the sentences. How the participants used the Enter key to break a new line without punctuating helped the researcher decide the border between two sentences as well.

This phase also involved preparing NVivo for coding by setting up a preliminary coding framework consisting of pre-determined themes identified from the literature review as well as from the pilot study carried out by Nguyen (2016). A detailed description of this initial framework will be provided in the next phase.

2.2. Coding

This phase was central to the whole data analysing process, where a comprehensive coding framework was gradually and ultimately developed, which, when each step was done with care and consideration, was likely to enable themes or patterns to emerge. In other words, it involved generating accurate codes that identified important features of the data that might be relevant to answering the research question, as well as coding the entire datasets, and after that, aggregating all the codes and all relevant data extracts together for later stages of analysis.

A code is defined as a label (normally in words or phrases) that describes accurately the feature and meaning of the segment it is tagged to (Braun & Clarke, 2006; Creswell, 2015). Codes can be stated in the participants' words, phrased in educational terms or written in the researcher's own words (Creswell, 2015). Segments of data conveying the same meaning are given the same code, and a new code is created and assigned to any new segment whose meaning does not fit in the codes previously created. A code is used interchangeably with a category in this study because, like a code, a category refers to "the descriptive level of text and is explicit manifestation of the participants' account" (Vaismoradi et al., 2016, p. 102).

The coding scheme for the transcripts of design conversations, both in-class and online, in this study was based on two different coding protocols. The first protocol was the one used in the pilot study (Nguyen, 2016). The second protocol was adopted from Koh and Chai (2016), as summarised in Table 2 below. The Nguyen framework was selected to promote conceptual continuity from the pilot study (Nguyen, 2016). The Koh and Chai framework was selected as one of the only contemporary and rigorous attempts to code teacher technology-enhanced learning design discourse.

The categories of Content, Technology, and Pedagogy in Nguyen's (2016) study were respectively similar to Content Knowledge (CK), Technological Knowledge (TK), and Pedagogical Knowledge (PK) in Koh and Chai's (2016) study in the way that they referred to the discussions pertaining to subject matter content, the use of technologies, and the use of pedagogical approaches respectively. In addition, Nguyen's list has a category called *Others* encompassing such sub-categories as *Scheduling*, *Allocating tasks*, and *Establishing a common-ground knowledge*. These sub-categories are quite similar to those that Koh and Chai found under the category of Design Knowledge (DK) related to which design process to adopt, how to choose their design goals,

how to organise the storage of their design draft, and how to allocate the design work among themselves. They are similar in that they are related to the participants' design strategies rather than other knowledge elements. An important point to note is Chai and Koh did not identify any discussions related to context and learners' characteristics in their study while Nguyen did.

Therefore, upon combining the two protocols together, this current study adopted a preliminary coding framework including 10 initial categories as shown in Table 2.

Table 2. Preliminary coding framework of the current study

	Categories	**Definitions**
1	Technological knowledge (TK)	Discussions related to the use of technological tools.
2	Pedagogical knowledge (PK)	Discussions related to the use of pedagogical strategies generally and certain specific approaches.
3	Content knowledge (CK)	Discussions related to subject content.
4	Pedagogical content knowledge (PCK)	Discussions related to the pedagogies related to subject-content that do not involve the use of ICT.
5	Technological pedagogical knowledge (TPK)	Discussions related to how ICT can be used to support particular pedagogies.
6	Technological content knowledge (TCK)	Discussions related to content-based ICT tools or the use of ICT for content representation.
7	Technological pedagogical content knowledge (TPACK)	Discussions related to the use of ICT to support particular pedagogies for particular subject content.
8	Design knowledge (DK)	Discussions related to the design process.
9	Context	Discussions related to potential school-related issues.
10	Learners' characteristics	Discussions related to potential learners.

An abductive approach to coding was applied, which involved both inductive and deductive approaches. That is, although there was a pre-determined list of categories, the researcher was prepared for any unexpectedly emerging categories. Table 3 shows an extended coding framework for the design conversations that includes names of codes, the meanings identified by them, and examples of the coded segments. It is the result of several months each year in two years working on transcripts of 15 and 18 in-class design conversations in C1 and C2 respectively (approximately 3000 words on average each), 27 and 21 Facebook Messenger chats in C1 and C2 respectively (on average approximately 500 words each).

Table 3. The extended coding frame work for design talks

	Main codes	**Meanings (sub-codes)**	**Examples**
1	**Technological knowledge (TK)**	Discussions related to the use of technological tools.	*Can the colour of graphs be changed on this app?*
		- Usage of tools	- *Is there a bit in Moodle where you can speak and record something?*
		- Combination of tools	- *I am just trying to think if there is a way to incorporate all the communication modes.*
		- Choosing and searching for tools	- *Before we do that, do you want to look at digital sandbox and figure out which one we want to because there are four of them that we could use?*
		- Comments on/ Understanding about technology	- *It [Powtoon] may be similar to the cartoon comic strip in that there will be a number of slides.*
2	**Pedagogical knowledge (PK)**	Discussions related to the use of pedagogical strategies.	*We can use reciprocal teaching here.*
		- Discussing teaching strategies	- *One of my lessons is going to have a quiz at the end.*
		- Mentioning and elaborating certain pedagogical approaches	- *Let's say Social Constructivism because I feel like that encompasses Constructivism.*
		- Pedagogies in Justification	- *So, the pedagogies for the justification, have you thought about yours yet?*
		- Class management	- *They have 15 minutes to research, then they have to get it done.*
		- Assessment	- *So formative is what you do as you're going throughout the unit to assess their learning and summative is what you do at the end of the unit.*
3	**Content knowledge (CK)**	Discussions related to subject content.	*Salt can be used to lower the temperature of ice.*
		- Mentioning subject content	- *Are you keen on Maths or English?*
		- Selecting content (resources)	- *Plus, for EDUC371 there's the whole phonics stuff and we can probably incorporate some of that to.*
		- Understanding of subject content	- *English is good. You can integrate other stuff.*

	Main codes	Meanings (sub-codes)	Examples
		- Types + ideas of learning tasks and activities	- *We can do things like people's perceptions of places.*
		- Choosing learning outcomes	- *Do we need to pick specific outcomes?*
		- Selecting design topics	- *We'll choose a topic first. What are your strengths, guys?*
		- Teaching and learning scenarios	- *Because it says "unsafe environments" with an 's', do you want to stick with one environment or a multiple environment?*
4	**Pedagogical content knowledge (PCK)**	Discussions related to the pedagogies related to subject-content that do not involve the use of ICT.	*Do you want students explain this to you so that you can assess their understanding?*
			- *Since the initial idea was to engage with this event/debate in history critically so that students would be able to think critically about current events/debates, maybe we should include something about this in Lesson 6 - Slight Chance of Tact.*
5	**Technological pedagogical knowledge (TPK)**	Discussions related to how ICT can be used to support particular pedagogies.	*Students can teach themselves through an app.*
			- *It makes it easier for student assessment while bringing modern tech into the classroom*
6	**Technological content knowledge (TCK)**	Discussions related to content-based ICT tools or the use of ICT for content representation.	*We can ask the students to video record their explanation of this math problem.*
		- Use of ICT for content representation	- *It [English] would probably work better with the Moodle format.*
		- Mentioning technology and content	- *I think I did it [a tool in discussion] when I did Japanese.*
		- Content-based ICT tools	- *They can do things like surveys.*
7	**Technological pedagogical content knowledge (TPACK)**	Discussions related to the use of ICT to support particular pedagogies for particular subject content.	*We will video-record the steps for solving this problem of Peter and post it on the social learning wall: After selling 2/5 of the eggs, Peter has 100 eggs in the bag. How many eggs did he have at first?*

	Main codes	Meanings (sub-codes)	Examples
			- *My thought was using it [an app] for the instructional video, where students choose their scenario to talk about and provide/present the emergency procedure for that scenario using their voice to explain the steps to take.*
8	**Design knowledge (DK)**	Discussions related to the design process.	*Let's identify the resources we need for this lesson.*
		- Steps in a design process	- So maybe we should leave the module aims and come back to that when we have a better idea of what exactly we are going for.
		- Organising storage/ Taking notes of design drafts/ideas	- *Should we make this into like a Google Document so we all can edit it?*
		- Allocating tasks	- *How do you want to do the PowerPoint? Should each of us do a part?*
		- Structuring a course or a lesson on Moodle	- *So we can probably just do it in two consecutive sections, not consecutive but two consecutive days or something like that.*
		- Scheduling and setting goals	- *Do you guys want to plan to meet up?*
		- Establishing a common ground awareness	- *Let's refresh our memories of what we were talking about with the English stuff because I can't even remember.*
		- Selecting year group	- *Let's choose what Stage first.*
		- Comments on current assignment	- *How long would the module have to go for?*
		- Comments on group work	- *We are getting through this pretty fast.*
		- Creating a group communication channel	- *We should probably have a communication about who is doing what using Facebook.*
		- Browsing or navigation during designing	- *You can press the arrows and they can show you where to go.*
		- Moodle design and aesthetic ideas	- *Going to make it [the group's online artefact] look pretty.*

	Main codes	Meanings (sub-codes)	Examples
9	**Context**	Discussions related to society, potential school, learner cohorts, facilities	Not present in Nguyen's (2016) and Koh and Chai's study (2016)
		- School (past, potential)	- *In my last school what they did was they actually had two separate maths groups.*
		- General questions about context in LDG	- *What is the context [of our online module]?*
		- Potential learner cohort	- *He said our context was like mixed abilities, mixed socio-economic statuses.*
		- Knowledge of NSW primary curriculum	- *In school do they aim to do one hour of tech a week or is it two hours of tech a week?*
10	**Learners' Characteris-tics**	Discussions related to potential learners benefiting from the design.	*Eight-year-old kids could deal with sorting objects and finding some features of living things*
		- Learners in relation to Moodle design	- *Is it [displaying course description] too much information though for kids?*
		- Age	- *Just bear in mind that they are Early Stage 1, so it's really going to need to be something simple.*
		- Interests and preferences	- *The kids would love fake news.*
		- Learners in relation to pedagogy	- *We've just got to make sure they [the kids] are very guided in a right way [and] scaffolded well.*
		- Learners in relation to content	- *They [the kids] are obsessed [with TBN].*
		- Learners in relation to technology	- *Would Early Stage 1 be able to use technology like a Moodle page?*
11	**Hindering factors**	Discussion related to hindrances participants encountered while designing in groups	Not present in Nguyen's (2016) and Koh and Chai's study (2016)
		- Lack of technological skills	- *I don't know how to set it [Google Docs] up.*
		- Computer and internet problems	- *My computer is a bit slow at the moment.*
12	**Supporting factors**	Discussion related to supporting factors participants received while designing in groups	Not present in Nguyen's (2016) and Koh and Chai's study (2016)

	Main codes	Meanings (sub-codes)	Examples
		- Group support	- *I'll have a look for you tomorrow.*
		- Tutor support	- *So we're asking him [tutor] about what we can use and what we actually really need to include.*
		- Educational past experience	- *When I did my lesson on it the other day, the one piece of advice that my teacher gave me was that you should kind of in a way not trick the students, but get them pre-engaged in Morocco and then bring out this book that has Morocco in it.*
		- Unit's resources and activities	- *I am excited [about the activity because] I need feedback.*

There were several important points to note with respect to Table 3. *First*, there were two levels of coding; that is, there was one level of child nodes to the corresponding parent nodes in NVivo. Hierarchical coding is beneficial in a way that the higher-order codes offer an overarching concept while lower-order codes clarify and justify the higher order codes or the main categories (King, 2004). In the current study, level-2 codes functioned as elements that, if put all together, created an operational definition of the level-1 code. This current study found 2-level coding useful and did not try to delve further into level 3 or 4 to avoid the confusion and challenges in data organisation and interpretation (King, 2004).

Second, some codes such as *Learners' characteristics* (LC) were double coded; that is, LC was a separate layer and not counted in the total number of the remaining codes for knowledge elements. Most of the time, the participants discussed LC in relation to one of the TPACK (Technological Pedagogical and Content Knowledge) constructs. For example, this sentence, "Maybe we should design some extra parts to tasks which will allow for students to equally participate regardless of language background", was coded as both LC and CK because the discussion was on what type of learning tasks (CK) to create to be suited to the potential learners' diverse language capacity (LC). Similarly, "It's bright for young kids" was coded as both LC (consideration of potential learners' young age) and DK (choice of bright colours in Moodle aesthetic designs).

Third, two more new codes emerging from the design conversations were added to the list of 10 original codes, resulting in 12 elements that the pre-service teachers attended to while designing their technology-based modules in groups. The two added codes were *Supporting factors* and *Hindering factors*, which were respectively defined as the factors that

encouraged or motivated participants during the process of collaborative design and as the hindrances the groups encountered while designing in groups. Illustrations of the former were "I'm going to ask the tutor about our lessons." and "If I read any good articles, I'll send them to you." whereas examples of the latter were "I don't know how to set it [Google Docs] up." and "My computer is a bit slow at the moment". The participants did not explicitly identify these examples as facilitating factors or hindering factors during their design conversations. It was the researcher who noticed that their discourses related to factors that supported or hindered their learning design practices. Most sub-categories under these two categories were coded as separate primary layers. The only one sub-category that was double-coded was *Educational past experience* as a supporting factor since their experience could be related to any of the TPACK and DK elements. In either case, their counts were not added to the final total of counts of TPACK and DK elements.

Fourth, extensive efforts were made to establish explicit boundaries between the codes, either main codes or sub-codes when it came to the circumstances where the two codes might look interchangeable. For instance, *Learners* was a sub-code of *Context* while there was a whole category of *Learners' characteristics* standing independently as a main code. However, a sentence was coded as *Learners* under Context when the participant teams discussed learners as an overarching element in determining potential class size and group division or when the teams specifically referred to learners as a contextual factor, whereas a sentence was coded as *Learners' characteristics* when learners were discussed in order to determine what content, technology, and/or pedagogy to use for the module being designed. An example of the former was "We are designing our Moodle for Carlingford West public school which has 97% of students from a language background other than English"; an example of the latter was "We should focus on making sure [that] it [the learning task in discussion] is engaging and that we can immerse the learners into it". There were no other major similarity issues with the remaining codes and sub-codes.

Several steps were taken to maintain the trustworthiness of the analysis during this phase. *First*, a coding manual that was created in the first phase (*Familiarising with data*) was used to detail definitions and examples of both old and new codes. Its content also included various versions of the framework. Reflective thoughts were captured and documented in the manual along the way to identify any interesting emerging aspects of the data. *Second*, changes to the original coding framework – or the addition of new codes and sub-codes – were updated on a weekly basis. In order to be easily identifiable and viewing facilitating, these

newly emergent codes and sub-codes were colour-coded in a way that the original codes/sub-codes were black; the next week, red; the following week, blue, and so on. This was particularly helpful for synthesising the whole process as well as reminding the researcher of how the framework was modified instantly. It also helped the researcher have a clearer idea of what new codes were added on and how the framework was developed over time. The trustworthiness in this phase was further enhanced by the inter-coder reliability check carried out twice at the completion of coding C1 and C2 data respectively (see Section 2.7 for inter-coder reliability results).

In brief, constant efforts were devoted to ensuring the trustworthiness of the phase. The final result toward the end of the C1 data analysing process was the comprehensive coding framework outlined in Table 3. This framework was then utilised for coding C2 design conversations and was found to be thorough and reliable since no additional emergent codes or sub-codes were added when used to code C2 data.

2.3. Searching for themes

Searching for themes amongst the coded data relates to searching for patterns in Braun and Clarke's thematic analysis approach (2006). Braun and her team defined a theme as "a common, recurring pattern across a dataset, clustered around a central organising concept" (Braun et al., 2019, p. 2). In order to discover if there were any themes related to the research questions under investigation, tables representing the distribution of different codes by week, by group and by individual were extracted using Matrix Coding queries in NVivo. For example, via examining the table illustrating Design Knowledge's frequencies over C1, the researcher found a repetitive trend around the concept of DK that the pre-service teachers tended to discuss more design-related issues in the final Moodle weeks than in the first Moodle weeks. A closer examination showed that this pattern was not only surfaced from data in C1, but also in C2. This theme was hard to identify via the memos because the participants discussed design-related issues every week. The quantification of qualitative data — or the frequency table — was better to enable it to be surfaced. This theme helped answer the research question by revealing the pre-service teacher knowledge elements as well as where, when and how frequently they were articulated during the design process.

In addition, some patterns were distilled from the memos written along the coding process and cross-validated with the codes. An example related to the concept of *Context*, where it was noted that all the participating groups rarely discussed *Context* compared to most of the other knowledge elements. This theme was validated by *Context*'s small distribution of the context-related units coded over both cycles.

In this phase, the researcher also kept detailed notes of the development of sub-

codes alongside the coding manual. All the emergent patterns were documented in notes.

2.4. Reviewing themes

According to Braun and Clarke (2006) and Nowell et al. (2017), this phase involves the refinement of the themes and, in some circumstances, the changes in the initial coding. Therefore, recoding is expected (Braun & Clarke, 2006). In the current study, a full list of sub-codes created in the first steps were compared and contrasted so that redundant sub-codes were collapsed, and similar and related sub-codes were pulled together to form categories.

In some cases, sub-codes in one big category were moved to another big category. For example, two sub-codes called *Selecting design topics* and *Ideas of learning tasks and activities* were moved from DK to CK with the rationale that topics and learning tasks belonged to the category of what to teach (content). Another example was *Browsing or navigation while design* was moved from DK to TK because during the navigation it was more like the participants were showing their technological understanding, for instance, "You can press the arrows and they can show you where to go".

In other cases, sub-codes that appeared to have similar meanings under the same category were merged in order to provide conceptual clarity and fidelity. To illustrate, upon thoughtful re-consideration, the researcher combined some sub-codes under DK together due to their similar nature. Specifically, *Scheduling* and *Setting goals* were combined to become one sub-code owning to their relevance to the teams' plans for the next design meetings. Similarly, discussions on *Copyright* and *Referencing* were merged into one sub-code since they were related in a way that the participant students needed to acknowledge the sources properly to uphold copyright which is a requirement for designing online courses and providing a scholarly justification. Also, *Getting to know each other* was added to *Establishing common-ground awareness* since self-introduction was also to establish mutual understanding.

The above modifications and reductions not only turned data into a more manageable set, but also allowed the surfacing of significant themes that accurately summarised the text (Nowell et al., 2017). In this phase, the researcher also went back and forth numerous times between the code lists and the original data to see whether any new codes had emerged and reached a point where the code boundaries were clear and comprehensive. This phase in the current study was conducted mainly in analysing C1 data. The researcher hardly had to change any codes and sub-codes established in the coding framework resulting from C1 coding process when she carried out a similar analysis on the set of data in C2.

2.5. Defining and naming themes

This fifth phase involves the decisions on what story each identified theme tells

and how each story helps elaborate the main concepts to answer the research questions (Braun & Clarke, 2006). If needed, the researchers can choose to further define and label certain themes. In this phase of the current study, detailed rationales were carefully recorded in the coding manual. All the individual themes were documented in full notes at this stage with examples considerately selected and tables extracted from data to be ready to tell stories.

For instance, in Phase 3 (Searching for themes), surrounding the category of *Group dynamics* there appeared three themes: *Peers supporting each other intellectually, Peers supporting each other technologically* and *Peer supporting each other emotionally*. These themes were then told in more complete stories in this phase by adding explanations of their meanings taken from sub-codes and being illustrated with quotes or numbers extracted from the data. These themes and the stories pertaining to them helped elaborate how the concept of *Group dynamics* was one of the factors supporting the pre-service teachers' learning design processes.

2.6. Producing the report

This final phase happens when all the themes are fully established and are ready for the write-up of an engaging, cohesive, logical, and accurate report (Braun & Clarke, 2006). In this writing up phase, the researcher made full use of the full-paragraph notes, carefully-selected quotes and well-presented tables which were prepared from the previous phases (this reporting can be found Nguyen's (2020) study). The memos in the coding manual were constantly referenced. Additionally, the researcher also made notes of the implications underpinning each theme for further discussion.

2.7. Inter-coder reliability for design talks

Inter-coder reliability (ICR) is a method of checking the agreement between two or more coders about how codes are applied to data in qualitative studies to guarantee the reliability and objectivity of findings (Kurasaki, 2000). ICR has been proposed and used in many qualitative studies (Kurasaki, 2000; Nili et al., 2017; Olson et al., 2016), especially in studies that adopted thematic analysis and developed detailed coding frameworks (Belotto, 2018; Roberts et al., 2019).

The ICR check for the set of design conversation data in the current study occurred once in C1 and once in C2. The C1 ICR check that occurred before continuing coding C2 data enabled the researcher to make necessary changes to the codes or sub-codes that resulted from the discussions between the researcher and the second coder. This included the researcher returning to the coding of transcripts and making adjustments. Then, the whole process of coding the C2 design conversations using the C1 coding scheme, in turn, was a good opportunity to check the reliability of the C1 coding framework.

On both occasions, ICR was conducted using the following steps, as suggested by Nili et al. (2017).

(1) Developing coding scheme

(2) Selecting and training independent coders

(3) Selecting method for evaluating ICR

(4) Calculating ICR

(5) Interpreting results

Step (1) involved the whole process of coding all the design conversations, from which a coding framework was developed by the researcher. Afterwards, an independent coder was recruited and trained (*Step (2)*). The second coder was among the tutors of the unit and, therefore, it was not hard for her to get hold of the key concepts in the TPACK framework as well as other unit-related issues. In C1, the researcher dedicated half of a 2-hour meeting to explaining to the other coder the purposes of the study, the role of this specific set of qualitative data (design conversations), the meanings of different concepts and codes involved, the subtle boundaries between some codes/sub-codes, and which codes were single or double coded. After that, the independent coder practised coding with a small amount of data on a randomly selected transcript in NVivo on a separate computer. The results were then compared with the researcher's codes and differences discussed. The same procedure was repeated with another small amount of data on the same transcript, by which time the second coder was more familiar with and confident about coding. Afterwards, she was asked to code another randomly selected C1 transcript independently without the researcher's presence. In C2, because the same independent coder was already familiar with the process, the researcher just needed to re-explain it briefly and let her code another randomly selected transcript from C2 data.

As for *Step (3)*, Cohen's Kappa coefficient (Cohen, 1960) was selected as a method for evaluating ICR. Cohen's Kappa was suitable because it was applicable for the nominal type of data of this study, allowed the assessment of agreement between two separate coders, reduced the effect of chance in agreement, and enabled the results to be quantitatively reported (Nili et al., 2017). Furthermore, Cohen's Kappa coefficient was conveniently chosen as a method of assessing ICR in NVivo where the coding took place. A simple percentage agreement measure was also used as a point of comparison. This was calculated as the ratio of the amount of coding where the coders agreed to the total amount of coding in the transcript.

In *Step (4)*, the two transcripts fully coded by the second coders, one in C1 and one in C2, were compared with the corresponding transcripts coded by the researcher using Coding Comparison Query in NVivo. The query provided both ways of measuring the degree of agreement between two coders or two

groups of coders: via calculating the percentage agreement and Kappa coefficient.

Out of the 12 final main nodes, only nine (KD, TK, CK, PK, TPK, CPK, TCK, TPACK, and Context) were chosen to calculate the final results although the independent coder coded all the possible nodes. The codes that involved two coded layers like *Learners' Characteristics*, *Supporting factors*, and *Hindering factors* were not included in the final calculation to avoid the overlapping counts of the total units coded. The weighted average Kappa coefficient was then calculated, weighted according to the percentage of the transcript coded by each node. Similarly, the weighted average Percentage Agreement was calculated, weighted by the amount of transcript coded by each node.

Step (5) involved the interpretation of the final results. The respective average Kappa score weighted by coding coverage for C1 and C2 were 0.813 and 0.853, the strength of agreement of which were deemed as almost perfect by Landis and Koch (1977). The respective average percentage agreement weighted by coding coverage were 0.738 and 0.781 for C1 and C2. The percentage agreement gained from both approaches to calculating was considered to be high, hence providing confidence in the reliability of the coding.

3. Conclusion

This paper has demonstrated step-by-step how to analyse pre-service teacher face-to-face design talks and Facebook chats adopting the thematic analysis approach initiated by Braun and Clarke (2006) interlaced with the standard trustworthiness in analysing qualitative data. This approach has been appropriate in enabling the themes, or patterns, to surface and thus facilitating the researcher in answering the research question in a productive way by allowing the researcher to examine the data thoroughly and logically. Findings from this data analysis approach were made more reliable with a follow-up inter-coder reliability check. Therefore, this approach is recommended to be further used in studies in the field of education in general and in pre-service teacher education in particular.

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