

2020

## Teacher Biography: SOLO Analysis of Preservice Teachers' Reflections of their Experiences in Physical Education

John E. Haynes

*The University of New England*, jhaynes2@une.edu.au

Frances Quinn

*University of New England*, fquinn@une.edu.au

Judith A. Miller

*University of New England*, jmiller7@une.edu.au

Follow this and additional works at: <https://ro.ecu.edu.au/ajte>



Part of the [Health and Physical Education Commons](#), and the [Higher Education and Teaching Commons](#)

---

### Recommended Citation

Haynes, J. E., Quinn, F., & Miller, J. A. (2020). Teacher Biography: SOLO Analysis of Preservice Teachers' Reflections of their Experiences in Physical Education. *Australian Journal of Teacher Education*, 45(4). <http://dx.doi.org/10.14221/ajte.2020v45n4.4>

This Journal Article is posted at Research Online.  
<https://ro.ecu.edu.au/ajte/vol45/iss4/4>

## Teacher Biography: SOLO Analysis Of Preservice Teachers' Reflections Of Their Experiences In Physical Education

John E Haynes  
Frances Quinn  
Judith Miller  
University of New England

*Abstract: Teacher biography, as a reflective practice, was implemented in the context of Physical Education in a primary teacher education course at a regional Australian university. Second year students were asked to provide descriptions of a critical incident they experienced at the primary or secondary level in a Physical Education or sporting context (N=214). Their responses comprised the data for this study and the Structure of Observed Learning Outcomes (SOLO) Model was used to determine the levels of complexity of the responses to 'alternatives for action' associated with these incidents. More responses were multistructural (48%), than relational (24%), and unistructural (23%), with extended abstract (3%) and the least, were prestructural (2%). The responses varied for gender and mode of enrolment (on or off campus). The findings that one third of students developed higher order (relational or extended abstract) responses challenge teacher educators to consider strategies to extend critical reflections.*

### Background

People learn from the continuity of their experiences, which can set up certain preferences and aversions and thereby influence future actions (Dewey, 1938). Long-lasting attitudes can be unintentionally learned from school encounters, and it is these attitudes which Dewey argues are what counts in the future. Consequently, preservice teacher education students (PSTES)<sup>1</sup> come to teacher education programs with a particular set of ideas and feelings about what it means to be a teacher (Lortie, 1975; Wrench & Garrett, 2012). These memories from their past experiences in school are ingrained, especially critical incidents where emotions are strong and enduring (Calderhead & Robson, 1991; Humphries & Ashy, 2006; Morgan & Hansen, 2008; Petrie, 2008). Such self-selected incidents, if left unchallenged or ignored, can influence the future teaching practices of primary school generalist teachers (Francis, 1997). Fernandez-Balboa (1998) contends that one's identity, or sense of self, is significant in terms of beliefs held, and approaches to teaching and learning. In essence, the personal and the pedagogical cannot be separated and one affects the other: what teachers do is tied to aspects of their identity. The personal experiences and critical incidents of PSTES have been shown to impact on the way they regard a subject and the confidence they have to engage with it, specifically for some subjects that may be perceived as difficult to teach such as Physical Education (PE) (Morgan &

---

<sup>1</sup>Preservice Teachers (PST) is more recently known in the New South Wales education directorate as Teacher Education Students (TES). For consistency, Preservice Teacher Education Students (PSTES) will be used in this manuscript

Hansen, 2008).

While the impact of experiences on PSTES personal identity and teaching practice is applicable across many subject areas, the specific problem at the core of this paper is the persistent and specific issue that strong aversions to Physical Education are carried into teachers' futures. These issues are often carried over from teachers' own negative primary or secondary school experiences, with the ongoing result of constraining their subsequent experience and teaching of PE once they themselves are teachers. School based incidents and experiences in PE or sport can have long term implications for the self-concept of the preservice teacher education student (Morgan & Hansen, 2008). Notions of what it means to teach PE may be indelibly embedded in an individual's psyche and until these are critically examined, then students are bound to repeat their own experiences in their teaching practices (Lawson, 1983; Morgan & Hansen, 2008; Ní Chróinín & Coulter, 2012).

This problem relates in part to the setting and nature of the PE context that can give rise to highly charged memorable school based incidents and entrenched beliefs influencing individuals' decisions, practices, and performance as future teachers of PE (Morgan, Bourke & Thompson, 2001). It is common for PE classes to be conducted in more open settings and outdoor learning areas such as playgrounds. In such circumstances, other teachers and students and sometimes members of the passing public can observe the students engaged in physical performances. Even in an interior setting, such as a gymnasium or school hall, pupils' performances are still 'on display' and their physical skills, or lack thereof, are open to scrutiny by their classmates. For students engaged in a range of Key Learning Area/subjects, none are as public as PE in their display of learning. This public display of motor skill learning is reported to make students feel they are placed in situations where they are apprehensive about participating fully (Dyson, 2006). Such exposure, coupled with the common practice of PE being taught as a sport-based event (Kirk, 2006; Light, 2008), can in some instances, lead to a situation whereby individuals are singled out for undue negative attention (Tischler & McCaughy, 2011; van Daalen, 2005). These circumstances can often lead to feelings of self-consciousness and negative self-concept (Pill, 2010).

Hence, an important part of preservice teacher education, especially in relation to PE, involves facilitation of PSTES reflections on their own stories as learners. This practice is suggested so students do not replicate unexamined approaches to their own classroom practice based on their own un-interrogated experiences (Walkington, 2005). The previous PE experiences, which have become a chapter of "teacher's stories to live by" also "offer many possibilities for change through retelling and reliving stories" (Clandinin, Pushor & Orr, 2007, p. 9). Through enhanced awareness and understanding of their own stories and experiences, PSTES can challenge themselves and enhance their teaching performance (Lee, 2005).

One powerful way to help effect positive change, by recasting experiences, is through teacher biography reflective exercises, which have been adopted internationally in relation to the development of generalist primary school teachers' identities (Kim & Tan, 2011). Engaging in teacher biography as part of their teacher education preparation is beneficial for PSTES, enhancing the practice and quality of PE in primary schools, by helping teachers to avoid some problematic teaching practices (Cardinal, Yan & Cardinal, 2013). Teacher biographies and the power of these experiences have an international appeal in helping PSTES develop a positive PE teaching identity (Cardinal, Yan & Cardinal, 2013; Curtner-Smith, 2007; Garrett & Wrench, 2007, 2008; Matanin & Collier, 2003; Morgan & Hansen, 2008).

The activity of including the teacher biography in the context of preservice teacher education programs has been reported previously by Haynes, Miller and Varea (2016), with the findings indicating that older students who have greater life experience, provided a more

enlightened recasting of their school-based experiences. However, there remains a broader question of the depth of this reflection activity. These reflective tasks can be a powerful and authentic form of learning, and therefore could be the basis of a purposeful assessment task. This experience leads to two important considerations in the design of teacher biography as a learning and possible assessment activity for PSTES:

- There needs to be a mechanism for assessing the quality of response to teacher biography work that is content and value-neutral.
- The framing of teacher biographies is important. The questions and cues need to be scaffolded to facilitate the relational thinking that is essential for teachers to apply information to different problems and domains (Biggs, 1999, p. 67).

Potential solutions to both of these design imperatives are provided by the Structure of Observed Learning Outcomes (SOLO) model (Biggs & Collis, 1980), a generic taxonomy that can be used to analyse the quality of students' responses to any cue, and also to guide the framing and scaffolding of questions designed to elicit higher order responses.

In this study, we are exploring the understanding of the role of teacher biography to progress the deconstruction of PSTES critical incidents as part of reflective practice, and investigating the levels and depth of the responses from the teacher biography exercise. Two of the three authors incorporated a teacher biography exercise as one of the learning activities for primary PSTES, and applied the SOLO taxonomy to assessing the quality of responses to this task. The research questions we are addressing are:

- What is the quality of reflection provoked by a teacher biography task, as assessed by a SOLO analysis of the complexity of responses to the task?
- Are there differences in the complexity of teacher biography responses across categories such as gender and mode of study?

In the following section a description of the SOLO model, as the conceptual framework of this study is provided.

## **The SOLO Model**

The SOLO model, previously referred to as a taxonomy, as proposed by Biggs and Collis (1980) can be used as a generic measure of the quality (and hence complexity) of responses to questions or cues across different disciplines. The model has been validated for use in a large range of disciplines (Hattie & Brown, 2004). SOLO is a neo-Piagetian model based on a developmental schema of classifying learning or levels of thinking in terms of their complexity, thus enabling the assessment of the quality of responses across any learning context.

The development of the Biggs and Collis (1980) SOLO model was strongly influenced by the well-known work of Piaget (1952) about how individuals learn. Biggs and Collis built on Piaget's (1952) ideas of stage theory and constructivism, along with the theories of Dienes (1960), Bruner (1966) and others, to formulate the processes involved in the SOLO model.

Based on the neo-Piagetian view of constructivism, the SOLO model comprises a hierarchy, of the levels of intellectual abstraction at which individuals of a particular age may function. The model includes five modes of learning: the sensorimotor; ikonic; concrete symbolic; formal; and, post formal. In those subject areas in which the upper secondary school students are particularly competent (and likely to continue into tertiary study) formal mode functioning may be observed (Collis & Biggs, 1991). Some learners never reach the formal stage, at which the foci of interaction are theories and abstractions, rather than the more declarative knowledge of the concrete symbolic stage. Most individuals do not achieve

the post-formal stage, which involves extending theory systems themselves. With increased retention rates in the senior years of schooling, it is likely that increasing numbers of senior students are operating throughout their studies at the concrete-symbolic level (Biggs & Collis, 1991). Within each mode there are different levels of response, which form one or more cycles of learning. The SOLO levels within each mode are based, in part, on the number and organisation of ‘elements’ contained in responses. “The elements are units or ‘bits’ of data relevant to the cue or question being responded to by an individual” (Biggs & Collis, 1982, p. 26) To undertake an analysis using SOLO, the response levels are categorised through the thorough and iterative determination of their complexity. A ‘no’ or an irrelevant response is classified as prestructural (P), a limited response, based on a single relevant aspect is classified as unistructural (U). Higher ranked responses may be either multistructural (M) whereby responses take account of several elements, or relational (R) responses that incorporate the interrelationships between elements. Finally, extended abstract (EA) responses represent an extension beyond the relational response in one mode to form a new single, more complex element of the next, more abstract mode. In a significant departure from classical Piagetian stage theory, the SOLO model recognises that individuals may ‘operate’ at different levels when responding to different intellectual challenges, or even under different environmental circumstances.

SOLO has been recognised as a useful model for measuring cognitive attainment and learning (Biggs, 2012; Slack, Beer & Armit, 2003). A simplified yet useful version of the SOLO model, devised by Panizzon (1999; as cited in Haynes, 2009, p. 65), is shown in Figure 1.

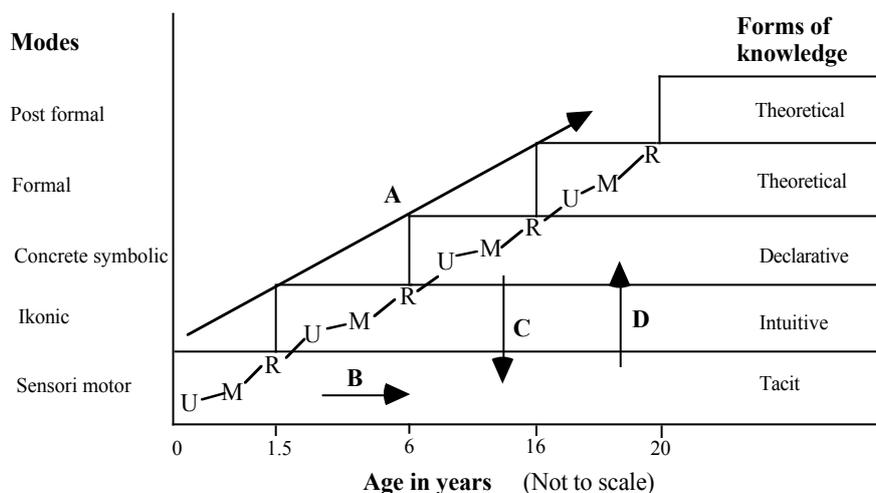


Figure 1: SOLO modes, levels and cycles of learning (Haynes, 2009, p. 65)

Figure 1 highlights four possible pathways of development – ‘A,’ ‘B,’ ‘C,’ and ‘D’ within the model. The typical pathway or course of optimal development assumed by stage theorists, (such as Piaget, 1952) in which a stage emerged and replaced its predecessor is represented by arrow ‘A’. This singular pathway is also a possibility within the SOLO model, however, in the majority of instances, growth within higher modes is supported by earlier modes. Alternatively, learning may involve the application of only one mode (arrow ‘B’) termed ‘unimodal’ functioning. In contrast, arrows ‘C’ and ‘D’ represent multimodal learning. Arrow ‘C’ according to Biggs and Collis (1991, p. 70) “demonstrates top-down facilitation of lower-order learning” as it identified those instances in which an individual uses higher-order modes to improve their performance in a mode acquired earlier.

Arrow ‘D’ is a ‘bottom up facilitation of higher-order learning’. In this case, modes acquired earlier are utilised to achieve learning in a developing mode. Such a pathway could be demonstrated in PE classes if students undertook activities in ikonic and concrete symbolic modes, such as moving body parts in a particular way, that facilitated their understanding of an abstract concept such as internal forces related to biomechanics, within the formal learning mode. With the exclusion of children of very young age, the SOLO model implied that a number of modes of learning were available to an individual for any particular learning situation.

Biggs and Collis (1991) hypothesized that for an individual to move from one cycle to the next there must be dissatisfaction, and being challenged with a problem appears to be a factor likely to promote change. Furthermore, these two authors also reinforced the idea that modal shifts occurred when individuals were forced to reorganise their prior knowledge when they attempted to solve a new problem. Accordingly, challenging the mindset of PSTES by inviting them to revisit a particular problem may initiate a change from one level or mode of thinking to another. This notion links with the ideas of Pines and West (1986) who espoused the importance of a conflict situation for cognitive growth.

## Method

This section provides information pertaining to the SOLO analysis of the PSTES descriptions of the critical incidents from their schooling, alluded to in the teacher biography exercise. There are seven sub sections commencing with the context of the study.

### Context

This study was conducted within a tertiary institution located in a regional area of New South Wales, Australia. All the participants were enrolled in an education teaching degree, which provides instruction to generalist primary school teachers. The term generalist indicates that the graduating teachers are required to teach all six primary school Key Learning Areas (KLAs) (i.e., subjects).

### Participants

There were two groups of students enrolled in the core pedagogy units for Primary School PE as part of their K-6 teaching degree. The mode of study differentiated the cohorts, as outlined in Table 1.

Cohort 1: ON Campus, 2nd year	Male	Female	Sub total
	14	52	66
Cohort 2: OFF Campus, mostly 4th year	Male	Female	Sub Total
	19	129	148
Number	33	181	Total 214

**Table 1: Participant details**

The average age of the PSTES varied with the mode of study: specifically, the *on* campus students were 20 years of age whilst the *off* campus cohort were 32 years of age. The ratio of females to males was slightly higher than is usual within the NSW primary school teaching profession (80%) (NSW Department of Education, 2018) with the percentage in this study of 88% female.

### **Teacher Biography Activity**

During the early teaching weeks of the semester the PSTES privately undertook a compulsory written reflective analysis, which was then submitted to the unit coordinator. They were prompted to choose any memorable incident that they were involved with or witnessed from their primary school PE lessons (either positive or negative) and initially describe the incident in detail. They then analysed the incident taking into consideration five questions: (i) what happened; (ii) who was advantaged or disadvantaged; (iii) how might others give meaning to the incident; (iv) how could the incident be handled differently from your perspective as a PSTES (alternatives for action); and, (v) what were the taken for granted assumptions from the perspective of both the teacher and the students (Francis 1997; Miller, Wilson-Gahan & Garrett, 2018). This report is based on answers given to question (iv), namely, *how could the incident be handled differently from your perspective now as a PSTES (alternatives for action)*.

### **Data Analysis**

There are two broad categories of the analysis. Initially, Leximancer was used to identify the co-occurring text, which then became the basis for the second form of analysis, namely, SOLO coding.

#### **Leximancer Analysis**

The preliminary textual data relevant to the question about their PE lesson incident were extracted from the written responses to the five different questions using the text mining software program Leximancer (Smith, 2000). This software is a method for transforming lexical co-occurrence information from natural language into semantic patterns in an unsupervised manner ... the software uses algorithms which are statistical, but employ nonlinear dynamics and machine learning (Smith, 2000; Smith & Humphreys, 2006). It should be noted that the main purpose of Leximancer is to analyse large amounts of text, into themes within concepts, and it is very much more sophisticated than a word counting instrument. A range of sources has verified the validity and reliability of Leximancer (Penn-Edwards, 2010; Smith & Humphreys, 2006) and the operational processes and advantages are accessible from other recognised academic sources (Smith, 2000; Sotiriadou, Brouwers & Le, 2014).

The search phrase 'alternatives for action' was used to extract the meaningful text surrounding this group of words. Of the total number of participants ( $N=214$ ) responses, thirty-one yielded no data that could be coded into a theme or concept by Leximancer, as their transcripts did not address directly or indirectly the specific relevant question.

Consequently, the total number of responses available for analysis was one hundred and eighty-three ( $N=183$ ).

### SOLO Analysis

The two concepts identified from the Leximancer output, and employed for the purpose of analysis were '*alternative*' and '*teacher*'. The relevant textual extracts identified by Leximancer for these two concepts were analysed using SOLO. Four procedural steps were enacted.

Firstly, all the responses for question (iv) extracted by Leximancer were printed on separate pieces of paper. From this point on, the process follows a pattern where responses were carefully read and the complexity of the responses determined. The various types of responses that showed a marked similarity in complexity were placed in piles. When responses appeared to deviate from the emerging patterns, they were put in a separate pile until the process of building piles was completed. This process allowed for a better understanding of where the outlying responses would fit. If a response still did not fit it became a pile of one response.

Secondly, a briefly worded summary description regarding why the responses were grouped into a common pile was undertaken. Following this step, a recheck was completed, as the possibility existed that some of the responses would no longer comply with the structural complexity of other responses for that pile. These non-fitting items were moved to a more appropriate pile or became a part of a new pile. Common themes and descriptions were arrived at, which acted as a summary, for the coalesced responses.

Thirdly, the piles of answers were arranged in order of quality, which was determined by considering the reasoning and complexity of the response. This process led to groups of responses that could be placed along a continuum of complexity. This step was undertaken by starting with the responses representing the lowest level, where the response focused on one thing or idea. Then responses at the next level were selected where there was a focus on a number of steps or ideas, and then responses were compiled where multiple ideas were linked. There were some in-between piles where it was evident that responses showed some attempt to provide more than one idea but did not quite achieve the objective. Similarly, there were responses that demonstrated a lot of 'things or information' but the link between them was not explicit. These categories/piles were closely re-examined to ensure a close-as-possible match with SOLO level descriptions namely: prestructural (P); unistructural (U); multistructural (M); relational (R); or, extended abstract (EA).

Finally, this whole process was repeated. As noted previously, the SOLO levels within each mode are based on emerging 'elements' evident in the data, that was focused on the 183 students' scripts that were codable. Table 2, provides lists of the 'key' words that link to each SOLO level.

SOLO Level	Some key elements (word usage)
Prestructural	No elements relevant to alternative strategies for dealing with the incident as a PSTE
Unistructural	should, good things, attitude, popular, normal, option, instruction, fair, praise, feel
<sup>2</sup> Multistructural	could, feedback, collaborative, learning, explanation, adapted, student-centred, variety, implement, communication, opportunity, motivation, encourage, demonstrate, decision making, understanding, enabled
<sup>3</sup> Relational	supporting, multiple, outlook, reinforced, environment, helping, acknowledging, evaluating, fulfilment, realised, impact, knowledge, relationships, adjust, range, include
<sup>4</sup> Extended Abstract	capabilities, reflecting on, create, pedagogies, modified, critiqued

**Table 2: Key elements of SOLO analysis**

Of note, the words in Table 2 are those appearing within the students' responses, that demonstrates the complexity of the language used at the different SOLO levels. The results section provides samples of the use of particular words within a context.

#### Data Coding Inter-rater Reliability Checks

The data were double checked for coding. With a time-gap of approximately ten days between coding, each of the three researchers coded the data independently, using the SOLO coding method described in the previous section. The blind coding results were compared, using a random sample of texts ( $n=40$ ), and the ensuing discussion addressed coding differences. There was an average of a 72% intercoder reliability co-efficient between the three coders. Initially this process was undertaken between the first and second author, and subsequently between the first and third author. This procedure was undertaken to increase the researchers awareness of, and immersion in, the data with the aim of increasing reliability.

#### Results

A response for each SOLO level is provided as an example in Table 3. These quotations are taken directly from the texts provided by different participants. As is evident in Table 3 the responses are predominantly declarative, and in the concrete symbolic mode.

---

<sup>2</sup> Scrutiny of the text following SOLO coding showed that lower level elements can appear with the higher-level SOLO responses, but higher-level elements are not present in lower SOLO levels.

SOLO level	Example
Prestructural	<p><i>"I could have decided to wander off around the then developing Sydney Olympic park at the time."</i></p> <p>No attempt to address the issue, and no understanding of what suitable alternatives may be presented evident in the data.</p>
Unistructural	<p><i>"Students should have had the option of completing the activities not in view of the whole class."</i></p> <p>The response focuses on a single aspect.</p>
Multistructural	<p><i>"As an alternative the teachers could have assessed students individually in a written exam. Another alteration that could have improved the task for select students would have been for the groups to have been randomly assigned, or picked by teachers."</i></p> <p>The response refers to more than one solution about the alternatives for action, but there is no connection between each alternative.</p>
Relational	<p><i>"There are plenty of alternatives to choose from when dividing students into groups that do not cause embarrassment, depend on popularity, leave anybody out, and be supportive. This can include giving everybody a number, grouping students alphabetically or even getting the students to choose a coloured pencil out of a selection of about four. The aim should be to divide students evenly, without anyone having to be chosen or left out. This means that the students still have the opportunity to be in a group with some of their friends, mingle with classmates that they may not usually associate much with and everyone is on more of an equal playing field. Throughout my past two professional experience placements, I often observed this method in the PDHPE lessons that were taught. It was in these placements that I realised how much of an impact previous experiences had on my own teaching style and methods. I will definitely never include this process of group selection when dividing up students in my classroom no matter what the subject area."</i></p> <p>The response makes a strong link between the various issues related to the solutions and their possible implications.</p>
Extended abstract	<p><i>"Alternatively, the teacher could have put the students into groups themselves, allowing the teams to be more even with no one feeling unwanted or left out. From my perspective the teacher should know each of their students' capabilities so they would know how to make equal teams, and should know from observation the friend groups of their students, and so should have been able to see the captains always just chose their friends and the more popular students. In element two of the professional teaching standards it is explained, "teachers should know their students and how they learn". As the teacher was not aware of the great effect this had on students, they could have used evaluations for lessons, including self-evaluations such as verbally from a range of students and nonverbally from observation"</i></p> <p>The response presents issues relating to the needs of a wide variety of individuals involved in the incident and beyond the scope of the original question.</p>

**Table 3: SOLO levels – Examples from preservice teacher education students' responses**

Table 3 provides examples that indicate the use of a variety of word elements, in addition to those listed in Table 2, that demonstrate a change in the complexity of the answers, and hence the move from prestructural through to extended abstract SOLO levels. The results for the application of SOLO coding to all responses for male and female and

mode of study (*on* and *off* campus) are shown in Table 4. However, to reiterate, text analysis was included only if there was sufficient information about the targeted question in the response to enable classification into an appropriate SOLO level, i.e., ( $N=183$ ).

SOLO Level	Cohort								Total Number No. (%)
	On Campus Female		On Campus Male		Off Campus Female		Off Campus Male		
	Number	%	Number	%	Number	%	Number	%	
Prestructural	1	2.7	0	0	1	1	0	0	2 (2)
Unistructural	9	24.3	6	43	22	22.7	6	43	43 (23)
Multistructural	23	62.2	6	43	53	54.6	5	36	87 (48)
Relational	10	27.0	2	14	29	30	3	21	44 (24)
Extended Abstract	0	0	0		6	6	1	7	7 (3)
Total	43		14		111		15		183

**Table 4: Statistics pertaining to SOLO levels**

As shown in Table 4, there are differences between on and off campus, and male compared with female students' responses. There are five major findings from this research with implications for preservice teacher education.

Firstly, the most prevalent SOLO response level was multistructural (48%), which was about double the frequency of both unistructural and relational responses at 23% and 24% respectively. Prestructural and extended abstract responses were relatively infrequent at 2% and 3% respectively.

Secondly, unistructural responses were more frequently produced by males than females, at 43% of males both on and off campus, compared to 24% and 22% of females. Thirdly, females present with the highest percentage of multistructural responses, both on and off campus. Fourthly, relational responses were more frequently constructed by females (27% on campus and 29% off campus), than males (14% on campus and 21% off campus). Finally, the extended abstract responses are only evident from off campus students (6% females, 7% males) with no examples for the on campus participants.

In summary, the quality of reflection provoked by the teacher biography task was variable, with some students engaging only superficially with the task, with approximately one third of the biography responses reflecting higher order (relational and extended abstract) levels of complexity. Moreover, females tended to produce more higher order responses and the highest quality responses were developed by off campus students.

## Discussion

The prevalence of the concrete symbolic responses in the results is partly due to the nature of the task, in that the question itself was not conducive to a more abstract response. That is, the question did not encourage students to draw on theoretical knowledge gained in previous university studies.

With regard to the levels of learning, the majority of responses fell within the multistructural level, which is a common finding for other research of tertiary students' SOLO based responses to a variety of research topics. These include: Lloyd and Mukherjee (2013) in the examination of preservice teachers' evaluations of ICT pedagogical practice; Chan, Tsui, Chan and Hong's (2002) investigation into students' learning outcomes; and Karaksha, Grant, Niru, Nirthanan, Davey and Anoopkumar-Dukie's (2014) work pertaining to E-Learning tools. Caniglia and Meadows (2018) determined that in two out of three

groups, the majority of responses were multistructural with the third group's responses determined to be unistructural when pre service teachers were asked to classify strategies used to solve 'One Question Problems'.

Hence, while the content and value-neutral nature of SOLO aligns itself well to assessing the quality of value and affect-laden personal reflective tasks such as teacher biographies, the preponderance of multistructural responses may also present a potential limitation of using SOLO to summatively assess such learning activities. Assessing teacher reflection is important, but has been shown to be problematic because of vague criteria and limited reliability levels (Lee, 2005). Having the majority of responses at the multistructural level may not be consistent with the level of discrimination expected of university summative assessment. So, while teacher biography is a very useful activity to include in PSTES for PE, consideration needs to be given to whether, and to what extent, such activities should form part of students assessment. However, we would argue that because of the power of assessment in engaging and driving student learning, it is appropriate for teacher biographies to be part of the assessment of a PSTE course. Notwithstanding, it is necessary that clear structural criteria of SOLO be incorporated to measure the depth of responses.

Of special note, male students studying in both the on campus and off campus mode presented with the highest percentage of unistructural responses, namely 43%, while the females' results were approximately half that figure. Both cohorts of females scored higher percentages for multistructural and relational responses when compared to their male respondents. These findings are consistent with evidence that females tend to outperform males in tertiary studies (Norton, Cherastidha & Mackey, 2018; Sheard, 2009; van Hek, Kraaykamp & Wolbers, 2016; Vialle, Thompson & Clark, 2008). However, these authors also raise questions about how best to engage all students, especially males, in the extended thinking and reflection that can facilitate re-storying of existing narrative and identity.

The extended abstract responses ( $n=7$ ) that were only found in the off campus cohort may well reflect the profile of this cohort, being on average, ten years older than the on campus group. This result is not surprising, given the recurring findings of research into higher education that mature-aged students exhibit more desirable deep and meaning-oriented approaches to their learning, partly because of their prior life experience (Richardson, 1994), and achieve higher final degree grade point average (GPA) compared to young undergraduates (Sheard, 2009).

## Conclusion

This research has been conducted in a PE pedagogy preservice primary teacher education program, and has focused on PSTES recollections of incidents that they experienced or witnessed during PE or sport whilst they were at school. The teacher biography exercise of recalling and recasting critical incidents and writing about their significance may provide a very powerful mechanism for helping PSTES to develop their teacher identities and improve their practice when teaching PE (Francis, 1997; Haynes, Miller & Varea, 2016).

If the aim is to facilitate PSTES to be able to link theory and practice in their subsequent teaching there is a need to provide scaffolding to elicit formal responses in reflective tasks such as teacher biographies. SOLO can be employed both to design the teacher biography tasks and determine whether theory has been applied in student responses. The paucity of responses in the formal mode is a key finding of this research and if the stated aim is for PSTES to be informed by theory then greater scaffolding is recommended for students to integrate appropriate theoretical concepts with their reflective practice.

In the context of our assessment tasks in the teacher education program, the practical value of the use of the critical reflection to improve the relationship between this well-established tool to recast critical incidents, is broadly established. To build on the findings of this research, the authors are scaffolding the teacher biography task to elicit a greater focus from the students on the multifaceted knowledge of best practice in Physical Education. The further exploration of the use of the SOLO taxonomy is a new approach in both the question and the assessment. This way forward has already been adopted by the research team, as a solution to the apparent lack of depth or complexity of responses as referenced by the SOLO model.

A specific question regarding the applicability of the teacher biography experience to future teacher practice has been adopted into the preservice teacher education program for the Primary Physical Education pedagogy units. Probes and prompts are being trialled to encourage a more relational response to the teacher biography activity. This action may also lead to a requirement for PSTES themselves to learn the theory of the SOLO model, in line with suggestions in a different higher education context (Prakash, Narayan, & Sethuraman, 2010), and how to apply it to enhance reflection on their experiences and their practice, specifically in relation to critical incidents in both their past, and their future. As SOLO is used in various ways across primary, secondary and tertiary education systems, this approach to analysis would be useful learning, quite apart from its specific application in teacher biography. SOLO can be, not only a useful way to evaluate and assess the quality of PSTES responses to a teacher biography task, but may also potentially help these generalist teachers to understand the connections between their own past experiences, and the kind of experiences they may provide to their own students.

## References

- Australian Bureau of Statistics. (2018). *Gender Indicators, Australia*. Canberra: ABS.
- Biggs, J. (Ed.) (1999). *Teaching for Quality Learning at University: Assessing for Learning Quality. II Practice*. Buckingham UK: SRHE and Open University Press.
- Biggs, J. (2012). Enhancing learning through constructive alignment. In J. R. Kirby (Ed.), *Enhancing the quality of learning: dispositions, instruction and learning processes* (pp. 117-136). New York: Cambridge University Press.  
<https://doi.org/10.1017/CBO9781139048224.009>
- Biggs, J., & Collis, K. (1980). The Solo Taxonomy. *Education News*, 17(5), 19 - 23.
- Biggs, J., & Collis, K. (1982). *Evaluating the Quality of Learning. The SOLO Taxonomy (Structure of the Observed Learning Outcome)*. New York: Academic Press.
- Biggs, J., & Collis, K. (1991). Multimodal learning and the quality of intelligent behaviour. In H. Rowe (Ed.), *Intelligence, Reconceptualization and Measurement* (pp. 57-76). New Jersey: Laurence Erlbaum Assoc.
- Bruner, J. S. (1966). *Towards a Theory of Instruction*. New York: Norton.
- Calderhead, J., & Robson, M. (1991). Images of teaching: Student teachers' early conceptions of classroom practice. *Teaching and Teacher Education*, 7(1), 1-8.  
[https://doi.org/10.1016/0742-051X\(91\)90053-R](https://doi.org/10.1016/0742-051X(91)90053-R)
- Caniglia, J. C., & Meadows, M. (2018). An Application of The Solo Taxonomy to Classify Strategies Used by Pre-Service Teachers to Solve “One Question Problems” *Australian Journal of Teacher Education*, 43(9).  
<https://doi.org/10.14221/ajte.2018v43n9.5>

- Cardinal, B., Yan, Z., & Cardinal, M. (2013). Negative experiences in physical education and sport: How much do they affect physical activity participation later in life? *Journal of Physical Education, Recreation & Dance*, 84(3), 49-53. <https://doi.org/10.1080/07303084.2013.767736>
- Chan, C. C., Tsui, M. S., Chan, M. Y. C., & Hong, J. H. (2002). Applying the Structure of Observed Learning Outcomes (SOLO) Taxonomy on Student's Learning Outcomes: An empirical Study. *Assessment & Evaluation in Higher Education*, 27(6), 511-527. <https://doi.org/10.1080/0260293022000020282>
- Clandinin, J. D., Pushor, D., & Orr, A. M. (2007). Navigating Sites for Narrative Inquiry. *Journal of Teacher Education*, 58(21). <https://doi.org/10.1177/0022487106296218>
- Collis, K., & Biggs, J. (1983). Matriculation, Degree Structures, and levels of Student Thinking. *Australian Journal of Education*, 27(2), 151 - 163. <https://doi.org/10.1177/000494418302700205>
- Curtner-Smith, M. D. (2007). The impact of a critically oriented physical education teacher education course on preservice classroom teachers. *Journal of Teaching in Physical Education*, 26(1), 35-56. <https://doi.org/10.1123/jtpe.26.1.35>
- Dewey, J. (1938). *Experience and education*. New York: Touchstone.
- Dienes, Z. P. (1960). *Building Up Mathematics*. London: Hutchinson.
- Dyson, B. (2006). Students' perspectives of physical education. In D. Kirk, D. Macdonald, & M. O'Sullivan (Eds.), *The handbook of physical education* (pp. 326-346). London: Sage. <https://doi.org/10.4135/9781848608009.n19>
- Fernandez-Balboa, J. M. (1998). Transcending masculinities: linking personhood and pedagogy. In L. Hickey, Fitzclarence, & R. Matthews (Eds.), *Where the boys are: masculinity sport and education* (pp. 121-139). Geelong: Deakin Centre for Education and Change.
- Francis, D. (1997). Critical Incident Analysis: a strategy for developing reflective practice. *Teachers and Teaching*, 3(2), 169-188.
- Garrett, R., & Wrench, A. (2007). Physical experiences: primary student teachers' conceptions of sport and physical education. *Physical Education and Sport Pedagogy*, 12(1), 23-42. <https://doi.org/10.1080/17408980601060234>
- Garrett, R., & Wrench, A. (2008). Connections, pedagogy and alternative possibilities in primary school education. *Sport, Education and Society*, 13(1), 39-60 <https://doi.org/10.1080/13573320701780514>
- Hattie, A. C., & Brown, G. T. L. (2004). *Cognitive Processes in asTTle: The SOLO Taxonomy*. Retrieved from University of Auckland/Ministry of Education.
- Haynes, J.E. (2009). *Qualitative Analysis of a Fundamental Motor Skill across the lifespan: Linking Practice and Theory* Unpublished doctoral thesis. University of New England, Armidale, NSW Australia.
- Haynes, J.E., Miller, J.A., & Varea, V. (2016). Preservice Generalist teachers enlightened approach to teaching physical education through teacher biography. *Australian Journal of Teacher Education*, 41(3). 21-38. <https://doi.org/10.14221/ajte.2016v41n3.2>
- Humphries, C., & Ashy, M. (2006). The confidence I needed: elementary education majors' perceptions of teaching physical education. *Teacher Development*, 10(2), 179-196. <https://doi.org/10.1080/13664530600773200>
- Karaksha, A., Grant, G., Niru Nirthanan, S., Davey, A. K., & Anoopkumar-Dukie, S. (2014). A Comparative Study to Evaluate the Educational Impact of E-Learning Tools on Griffith University Pharmacy Students' Level of Understanding Using Bloom's and SOLO Taxonomies. *Educational Research Journal*, 2014(934854), 1-11. <https://doi.org/10.1155/2014/934854>

- Kim, M., & Tan, A. (2011) Rethinking Difficulties of Teaching Inquiry-Based Practical Work: Stories from elementary pre-service teachers, *International Journal of Science Education*, 33(4), 465-486, <https://doi.org/10.1080/09500691003639913>
- Kirk, D. (2006). Sport education, critical pedagogy, and learning theory: toward an intrinsic justification for physical education and youth sport. *Quest*, 58, 255-264. <https://doi.org/10.1080/00336297.2006.10491882>
- Lawson, H.A. (1983). Toward a Model of Teacher Socialization in Physical Education: The Subjective Warrant. *Journal of Teaching in Physical Education* 3(2) 3-16. <https://doi.org/10.1123/jtpe.2.3.3>
- Lee, H. J. (2005). Understanding and assessing preservice teachers' reflective thinking. *Teaching and teacher education*, 21(6), 699-715 <https://doi.org/10.1016/j.tate.2005.05.007>
- Light, R. (2008). *Sport in the lives of young Australians*. Sydney: Sydney University Press.
- Lortie, D. C. (1975). *Schoolteacher: A Sociological Study*. Chicago, IL: University of Chicago Press.
- Lloyd, M., & Mukherjee, M. (2013). Tell Me What You See: Pre-Service Teachers' Recognition of Exemplary Digital Pedagogy. *Australian Educational Computing*, 27(3), 85-94.
- Matanin, M., & Collier, C. (2003). Longitudinal Analysis of Preservice Teachers' Beliefs about teaching Physical Education. *Journal of Teaching in Physical Education*, 22(2), 152-168. <https://doi.org/10.1123/jtpe.22.2.153>
- Miller, J., Wilson-Gahan, S., & Garrett, R. (2018). *Health and Physical Education: Preparing educators for the future*. 3rd Edition, Cambridge University Press. Port Melbourne, Vic.
- Morgan, P., Bourke, S., & Thompson, K. (2001). *The Influences of Personal School Physical Education Experiences on Non-Specialist Teachers Attitude*. Paper presented at the The Annual Conference of the Australian Association for Research in Education Fremantle.
- Morgan, P., & Hansen, V. (2008). The relationship between PE biographies and PE teaching practices of classroom teachers. *Sport, Education and Society*, 13(4), 373-391. <https://doi.org/10.1080/13573320802444994>
- Ní Chróinín, D., & Coulter, M. (2012). The impact of initial teacher education on understandings of physical education: Asking the right question. *European Physical Education Review*, 18(220). <https://doi.org/10.1080/13573320802444994>
- Norton, A., Cherastidham, I., & Mackey, W. (2018). *Mapping Australian higher education 2018*: Grattan Institute.
- NSW Department of Education. (2018). *Gender Analysis of School Teachers*
- Panizzon, D. (1999). *Senior secondary and early tertiary science students' developmental understandings of diffusion and osmosis: A neo-Piagetian approach*. ( Doctoral Thesis), University of New England, Armidale.
- Pegg, J., & Tall, D. (2005). The fundamental cycle of concept construction underlying various theoretical frameworks. *ZDM*, 37(6), 468-475. <https://doi.org/10.1007/BF02655855>
- Penn-Edwards, S. (2010). Computer Aided Phenomenography: The role of Leximancer Computer Software in Phenomenographic Investigation. *The Qualitative Report*, 15(2), 252-267.
- Petrie, K. (2008). Physical education in primary schools: holding on to the past or heading for a different future? *Journal of Physical Education New Zealand*, 41(3), 67-80.
- Piaget, J. (1952). *The origins of intelligence in children*. New York: International Universities Press. <https://doi.org/10.1037/11494-000>

- Pill, S. (2010). Sport literacy: it's not just about learning to play sport via 'textbook techniques'. *Journal of Student Wellbeing*, 4(2), 32-42.  
<https://doi.org/10.21913/JSW.v4i2.723>
- Pines, L. A., & West, L. H. T. (1986). Conceptual understanding and science learning: An interpretation of research within a sources- of -knowledge framework. *Science Education*, 70(2), 583 - 604. <https://doi.org/10.1002/sci.3730700510>
- Prakash, E. S., Narayan, K. A., & Sethuraman, K. R. (2010). Student perceptions regarding the usefulness of explicit discussion of "Structure of the Observed Learning Outcome" taxonomy *Advanced Physiology Education*, 34, 145-149.  
<https://doi.org/10.1152/advan.00026.2010>
- Sheard, M. (2009). Hardiness commitment, gender, and age differentiate university academic performance. *British Journal of Educational Psychology*, 79, 189-204.  
<https://doi.org/10.1152/advan.00026.2010>
- Richardson, J. T. (1994). Mature students in higher education: I. A literature survey on approaches to studying. *Studies in Higher Education*, 19(3), 309-325.  
<https://doi.org/10.1080/03075079412331381900>
- Slack, F., Beer, M., & Armit, G. (2003). Assessment and Learning Outcomes: The Evaluation of Deep Learning in an On-line Course. *Journal of Information Technology Education*, 2. <https://doi.org/10.28945/330>
- Smith, A. (2000). *Leximancer: From Words to Meaning*. Brisbane: Leximancer Pty Ltd and University of Queensland.
- Smith, A., & Humphreys, M. (2006). "Evaluation of Unsupervised Semantic Mapping of Natural Language with Leximancer Concept Mapping.". *Behavior Research Methods*, 38, 262-279. <https://doi.org/10.3758/BF03192778>
- Sotiriadou, P., Brouwers, J., & Le, T. A. (2014). Choosing a qualitative data analysis tool: a comparison of NVivo and Leximancer. *Annals of Leisure Research.*, 17(2), 218-234.  
<https://doi.org/10.1080/11745398.2014.902292>
- Tischler, A., & McCaughy, N. (2011). PE Is Not for Me. *Research Quarterly for Exercise and Sport*. <https://doi.org/10.1080/02701367.2011.10599720>
- van Daalen, C. (2005). Girls' Experiences in Physical Education: Competition, Evaluation, & Degradatio. *The Journal of School Nursing*, 21(115).  
<https://doi.org/10.1177/10598405050210020901>
- van Hek, M., Kraaykamp, G., & Wolbers, M. H. J. (2016). Comparing the gender gap in educational attainment: the impact of emancipatory contexts in 33 cohorts across 33 countries *EDUCATIONAL RESEARCH AND EVALUATION*, 22(5-6), 260-282.  
<https://doi.org/10.1080/13803611.2016.1256222>
- Vialle, W. J., Thompson, P., & Clark, M. A. (2008). Examining the gender gap in educational outcomes in public education: involving pre-service school counsellors and teachers in cross-cultural and interdisciplinary research. *International Journal for the Advancement of Counselling*, 30, 30(1), 52-66.  
<https://doi.org/10.1080/13803611.2016.1256222>
- Walkington, J. (2005). Becoming a teacher: encouraging development of teacher identity through reflective practice. *Asia-Pacific Journal of Teacher Education* 33(11) 53-64.  
<https://doi.org/10.1080/13803611.2016.1256222>
- Wrench, A., & Garrett, R. (2012). Identity work: stories told in learning to teach physical education. *Sport, Education and Society*, 17(1), 1-19.  
<https://doi.org/10.1080/13573322.2011.607909>