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# Measuring early childhood educators' time at work using an electronic random time-sampling approach

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**ABSTRACT**

Despite the acknowledged complexity of early childhood educators' work, little is documented about how early childhood educators actually spend their time at work. A typical way of studying time at work is through the use of time-use diaries. Recent developments have shown the benefits of using randomized sampling electronic time-use diaries. This paper reports on the development and useability testing of a random time sampling (RTS) time-use smart-phone application to capture the work of educators, the first time such a method has been used in early childhood settings. Descriptive analyses were conducted of time use data collected from 20 Australian early childhood educators. Seventeen went on to participate in follow-up focus groups / interviews, which were thematically analysed. The paper demonstrates the capacity of RTS apps to gather accurate and useful data about educators' work, and points to the acceptability of this method to educators, and its manageability within early childhood settings. Limitations of the method, including, participant buy-in, design and technical requirements, and cost, are also highlighted.

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Early childhood education; workforce; time-use; work activities

## Introduction

High-quality early education is linked to improvements in children's developmental outcomes and life trajectories, particularly for children who are at risk from social, economic or educational disadvantage (Melhuish *et al.* 2015). As a result, governments are investing in early childhood (EC) education (OECD 2017). Central to achieving the objectives that governments and families seek through such investment (Manning *et al.* 2019) is the work of EC educators.[1] However, the attainment of these objectives is premised on having a 'high-quality, educated, and stable workforce' and threatened by EC workforce shortages (Totenhagen *et al.* 2016, p. 585). We argue that a clearer grasp of the nature of EC educators' work is needed to better understand how their daily interactions with children promote effective EC programmes (Hamre 2014) and to attract, prepare, recognize, support and retain a high-quality workforce (Fenech *et al.* 2021).

The work EC educators do to ensure children receive high quality education is complex, involving emotional, pedagogical (or instructional), and organizational interactions with diverse groups of

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children (Hamre 2014). EC educators work with children of various ages and abilities; with families from diverse cultural and linguistic backgrounds; and with families and children with complex needs. The work also requires skills to collaborate with colleagues with varying levels of qualification and across professional divides. Further, educators must be aware of, and comply with, multiple legislative requirements. Despite the importance and complexity of this work, there is surprisingly little known about the detail of EC educators' work activities.

To address this issue, researchers have sought to document how EC educators spend their time at work through time-use diaries (Rudd 1999; Ryan *et al.* 2004; Kusma *et al*. 2011; Harrison *et al*. 2019; Mitchell *et al*. 2019). Time use methods have been used for decades, including in educational contexts (Vannest and Parker 2010), using both self-reported and observer-recorded diaries. More recently, research has moved towards designing electronic methods for gathering time-use data.

This paper describes the development, drawing on a Human Centred Design (Giacomin 2014) approach, of an electronic random time-sampling diary (RTS app) for use in early childhood education and care (ECEC) contexts. The paper presents findings from usability testing (Lemon *et al*. 2020) of the RTS app with a targeted sample of Australian EC educators. The paper points to the potential of the method for gathering data, as well as the challenges faced in using this method in the ECEC context. We commence with a description of time-use methods, how they have been used to record work-time activities (including in ECEC contexts), and the challenges of using diary methods in work-based contexts.

## *Time-use diary methodology*

Originating in the 1920s (Bauman *et al.* 2019), time-use diary methodology makes it possible to capture the rhythm and intensity of participants' typical day. It enables intensive study over a limited period of participants' actions and psychological states, as well as where, when and for how long activities occurred (Bolger *et al.* 2003). Time-use data can be: event-contingent – used to record when and how often a particular event happens in a day; interval-contingent – completed at regular, predetermined times; or signal-contingent – completed when an external (usually randomly generated) prompt is received (Bolger *et al.* 2003). When the intention is to capture time-use across a whole day, diaries can be completed retrospectively at the end of the day, or concurrently, continuously recording activities as they happen. Time allocations can be open-ended, with participants recording the starting and finishing time of an activity or divided into predetermined time intervals.

The content that time-use diaries record varies. Some studies provide space for participants to write descriptions of their activities, whereas others are populated by the researcher with pre-coded activities. Examples of pre-coded time diaries are those developed for the U.K. Millennium Cohort Study (Chatzitheochari *et al*. 2015) and the Longitudinal Study of Australian Children (Colliver *et al*. 2022). Some diaries capture only the main activity participants were engaged in (referred to as primary activities); whereas others also record secondary or multiple activities that occur either simultaneously or sequentially within a period of time. The latter are useful for identifying how and when participants multi-task, and potentially capture a more nuanced and composite picture of the complexity of the participants' days, than those that only record primary activities (Drago and Stewart 2010).

## *Time use diaries of work in educational settings*

In contrast with a large number of time-use studies of household work (Bauman *et al.* 2019) and the increasing use of time-use methods in large-scale longitudinal studies to understand 'population activity patterns and their relationship with long-term outcomes' (Chatzitheochari *et al*. 2015, p. 6), relatively little research has used time-use diary methods to study the work of employees in educational settings. Vannest and Parker (2010) assert that how teachers 'spend their time is largely anecdotal and based only on assumptions', pointing to the 'lack of data, instruments, or

procedures' for determining teachers' time-use (95). Nevertheless, the studies that have been conducted of time-use in school settings have been valuable for showing the diversity (Reeves *et al*. 2010) and intensity (Ngwenya 2012) of teachers' and principals' work (Horng *et al*. 2010). Studies have also identified the degree of teachers' multi-tasking (Brante 2009) and demonstrated the amount of time teachers work outside of contracted paid hours (Reeves *et al*. 2010; Department for Education 2014).

Likewise, studies of time-use in ECEC settings are rare, despite reports of the 'persistence and significance of notions of time' for EC educators (Nuttall and Thomas 2015, p. 512). To our knowledge, the first use of time-use diaries in ECEC was Rudd's (1999) study, in which participants (educators, teachers, and administrators) completed an open-ended diary divided into 30-minute blocks. This was followed-up with observations of 21 of the original participants. Findings revealed 'the diversity, multiplicity and complexity of the work of EC professionals' (Rudd 1999, p. 57). Similar findings were reported by Ryan and colleagues who used telephone interviews to retrospectively record the work, and the time spent in each activity, of EC coaches (Ryan *et al*. 2004) and mentors (Ryan and Hornbeck 2004). Taking a different approach, Kusma *et al*. (2011) collected time-use data concurrently via hand-held electronic devices with pre-coded categories of work activity, while 'shadowing' EC educators over a three-day period. Harrison *et al*. (2019) used a taxonomy of distinct domains of EC educators' work (Wong *et al*. 2015) to code handwritten diary records of work completed by 21 EC educators over a working day. Wong *et al*.'s study was replicated by Mitchell *et al*. (2019) in Aotearoa New Zealand, resulting in small amendments to the Taxonomy for that context. Findings reported by Kusma *et al*. (2011), Harrison *et al*. (2019) and Mitchell *et al*. (2019) highlighted the variety, intensity and complexity of educators' workflow, including high levels of task-rotation and multi-tasking.

### *Methodological challenges and innovations in work-based time-use diary research*

Despite the demonstrated value of using time-use methods for revealing the detailed nature of educators' work, there are methodological challenges. For example, Rudd (1999) reported a low response rate of 41/100 returned diaries, which she postulates may have been due to the burden on participants of completing the diaries. Likewise, participants in Mitchell *et al*.'s (2019) study reported that completing the written diaries was time-consuming. Harrison *et al*. (2019) also reported the time burden on educators of completing written diaries, as well as the cost burden of data transfer, coding and analysis of pen and paper diaries. Kusma *et al*. (2011) similarly noted the cost of using observers to collect data, as well as possible intrusiveness on educators' normal working day.

Writing about studies of 'working time' in general, Bittman (2016) identified three recurring, interconnected challenges that can threaten the viability and accuracy of time use research: (i) participants' (un)willingness to cooperate; (ii) burden on participants; and (iii) accuracy of recording. Participants may mistrust time-use studies if they feel that their individual work performance is being surveilled. As a result, they may be unwilling to participate, or may complete the diary to show their work in a more favourable light. Additionally, participants may not complete time-use diaries accurately if they are difficult or time-consuming to complete. These drawbacks contribute to the challenge of gathering detailed accurate records of the 'nature, duration and timing of the tasks undertaken in the course of a working day' (Bittman, 2016, p. 4). Bittman (2016) identifies two recent developments in time-use methods that address issues of burden and data accuracy: the use of pre-coded electronic (i.e. technology based – smartphone / computer) time-use diaries; and random time-sampling. It is generally accepted that completion of an electronic time use diary is easier for participants than pen-and-paper diaries, and potentially more accurate, and thus may result in an improved response rate (Malinen *et al*. 2015). Pre-coded time-use diaries reduce burden on both participants and researchers by simplifying both data entry and data transfer. This method also enables easy collection of demographic and other additional 'point in time' data, such as emotional markers (Malinen *et al*. 2015).

Nevertheless, Bolger *et al.* (2003) note that electronic time-use diaries have their pitfalls. They are expensive to develop; their use is contingent on participants having access to the technology, and the skills, knowledge and capacity to use it; and training may be required. Training is difficult for data collection with large samples where researchers cannot provide face-to-face support. With the increasing use of smart-phones, however, more people are familiar with this technology, and potentially more comfortable with participation in electronic time-use diary research. Still, there are legitimate concerns about how the 'digital divide' may impact on participation amongst some groups in the population.

A further benefit of smart-phone methods is the ease with which smart-phones can facilitate random time sampling, through the option for signal-contingent notifications to complete data collection to occur at random times (Bittman 2016). Small amounts of data gathered across a working day from a large sample can be used to 'build a representative picture of the average time per day that a sub-population spends in various activities, when they do each activity and for how long' (Bittman 2016, p. 5) providing a 'composite' of a 'typical' workday. Assuming a large sample size, random time sampling allows for a drastic reduction in the burden of recalling and recording work activities. Bittman (2016) suggests that this picture of a typical working day can be achieved by collecting intensive data for 'a random hour' three times a day over a period of 2–3 weeks.

### *Developing a random time-sampling time-use diary for early childhood*

Heeding the challenges and recommendations from Kusma *et al*. (2011), Harrison *et al*. (2019) and Bittman (2016), we used a Human Centred Design (HCD) approach to develop a pre-coded electronic time-use diary smartphone application (app) to gather random one-hour samples of EC educators' work. According to Giacomin (2014), HCD is a pragmatic and applied approach to the development of tools and systems which aims to make the product usable by end users. HCD involves multi-disciplinary collaboration in the design process resulting in products 'which are physically, perceptually, cognitively and emotionally intuitive' (Giacomin 2014, p. 610). Below we describe how the RTS app was developed, the type of data it collects, and its useability testing. Whilst this approach has been used successfully in the medical field to develop and test medical apps (Harte *et al*. 2017; Lemon *et al*. 2020), as far as we are aware, this is the first instance of HCD being used to develop and test electronic apps in ECEC settings. context.

To develop the RTS app we worked with a research / technical team who had previously developed a time-use smartphone app for social science academics working in higher education (Bittman 2016). Two versions of the RTS app were created: one for Apple's iOS platform, another for Android platforms. The app was designed to send two notifications per day, at random times between 8am and 6pm, Monday to Friday. On the first download of the app, participants complete a set of one time only questions and pre-coded response categories about themselves (e.g. qualifications, position, age, etc) and their workplace (e.g. type of service, age of children they work with, etc).

Each notification alerts participants to recall the previous hour of work-time via a beep or vibration. If the respondent is not able to enter data when they receive a notification, or misses the alert, the programme generates three reminder notifications at 10-minute intervals. To accommodate educators who work part-time, notifications start with the question 'Is this a working day?' and further alerts are only received if respondents enter 'Yes'.

The RTS app is pre-coded to capture, as accurately as possible, details of what work activities had been undertaken in the previous 60 min, where these activities were done, and who the educators were with for each of the activities. Participants recorded the time spent in each activity in blocks of 6 min. Six-minute blocks provide an 'internationally acceptable level of precision' (Bittman 2016, p. 7) and ten blocks of six minutes fit comfortably on a smartphone screen, allowing easy entry of the hour's activities. If an hour is missed because participants are unable to complete the app, it is added to the allocated hours to ensure the requested number of hours are collected. Upon

completion of data entry for each time point, data are automatically uploaded to a secure 'cloud' server when the device is connected to the internet (e.g. via a service's wi-fi connection). In this way, anonymized data is transferred regularly to facilitate safe storage.

### *Nature and duration of work*

Activities (i.e. what educators were doing) were pre-coded according to the *Taxonomy of Early Childhood Work* (Wong *et al*. 2015). The taxonomy identifies ten broad domains of educators' work, and within these, 55 sub-classes of activity (see Table 2 for nine Domains and sub-classes). The Taxonomy is a comprehensive codification system for the different tasks, activities and actions performed by early childhood educators in Australian early childhood settings (Wong *et al*. 2015). Using the Taxonomy for the RTS app enabled the diversity of educators' work, including pedagogical, routine care, relational and administrative aspects, to be fully captured.

To complete the first block of time in the RTS app, educators select the primary activity undertaken from one of the ten domains. After selecting the primary activity, educators then select a sub-class of activity. For example, for primary activity code 2: 'Being with children', the sub-class options are: 21 'Watch / scan / supervise'; 22 'Play with children'; 23 'Listen / respond to children'. Once educators enter the total time spent and the sub-class detail for their primary activity, the app is programmed to ask if they were doing another activity *at the same time* as the main activity just recorded. If respondents enter 'yes', they are offered the opportunity to select a secondary activity from the above list of ten domains and sub-classes. This sequence is illustrated in Figure 1.

For each entry of 'what' work activities were undertaken, educators select from a set of pre-coded options about 'where' the activity took place ('Inside playroom', 'Outside play area', 'Out of centre), and 'who' they were with ('Individual child', 'Small group of children (2–5), and 'Large group of children (>6)).

The above sequence of entering primary / secondary activities and context information is repeated until all 10 blocks of time (total of 60 min) are completed. Once the full 60 min of activity have been recorded, participants are shown a confirmation screen (see Figure 2), which summarizes the sequence of main activities (shown in black), simultaneous activities (shown in grey), along with their durations in the last hour. At this point, participants have the opportunity to spot any gaps or errors and to go back and re-enter the information. After confirming the details of the work

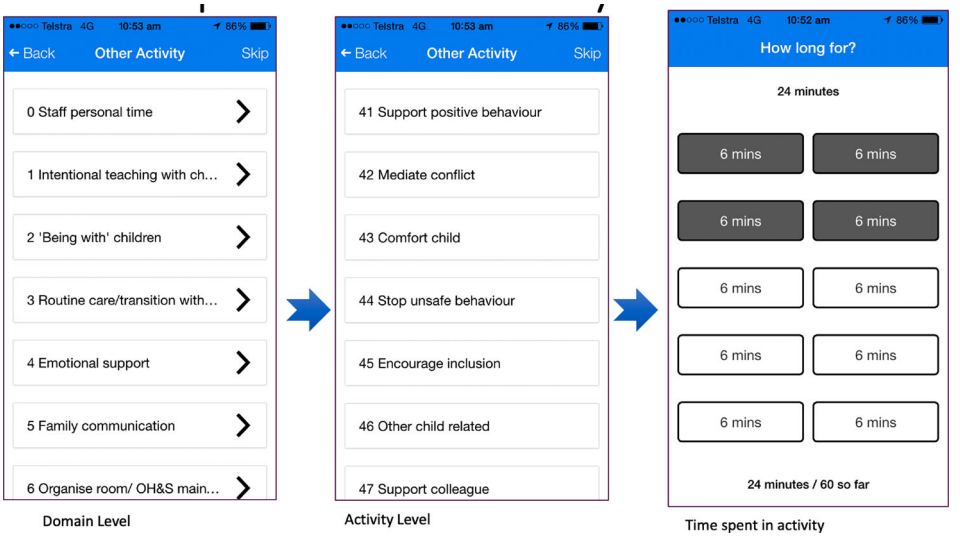


**Figure 1.** Sequence of selecting domain, activity & time spent in the activity.

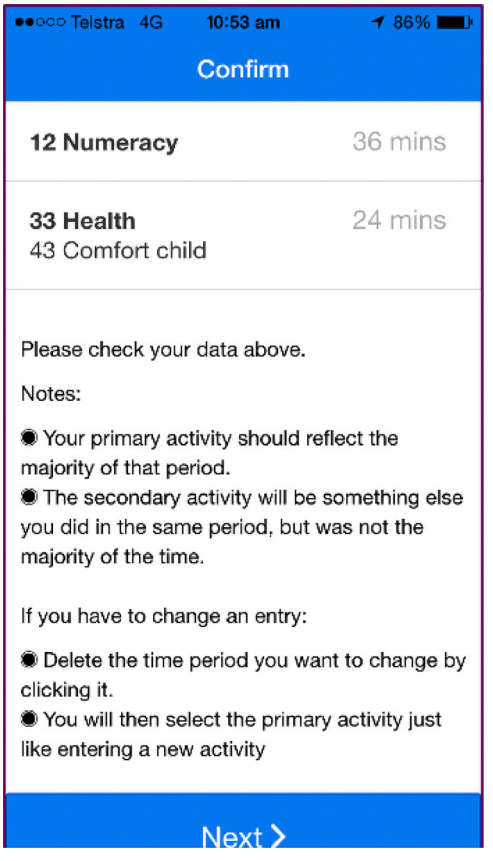


**Figure 2.** Confirmation screen.

completed during the hour, educators are asked to indicate if they were with other people, using pre-coded options: another professional, a parent / family member, or visitor.

### *Self-ratings about their work experience and stress*

A unique aspect of the RTS app is the inclusion of a short set of questions that ask educators to rate their experience of the hour of work on which they had reported. In contrast to most EC workforce research, which relies on overall summary measures of how educators feel about the workplace (e.g. satisfaction: Wagner and French 2010; enjoyment: Kontos and Stremmel 1988; stress: Nislin *et al.* 2016), our approach sought to 'capture fluctuation or transitory moods states (and the circumstances in which they occur)' across a working day (Bittman 2016, p. 21). After recording their work activities for the hour, educators are asked to rate four aspects of their 'real-time' experience of that hour (Bittman, 2016, p. 25): rushed ('How rushed did you feel during the past hour?'); satisfaction ('How satisfied did you feel about this task?'); job demands (Were different things being demanded of you during this task?'); and stress ('How stressed did you feel during the past hour?'). For each question, educators respond by selecting a number on a scale of 1 (not at all) to 10 (very).

## Testing useability of the RTS time-use diary app for early childhood educators

HCD recognizes useability testing as critical to the success of design (Maguire 2001). Without testing with end users, products may prove difficult to use, complicated to operate, or unworkable in

particular contexts. In this case, the RTS app needed to: (i) gather accurate data; (ii) be technically capable and functional; and (iii) be manageable and doable within the EC context. The key research questions for useability testing, therefore, were:

(1) How effective is the RTS app for gathering data about educators' time-use?
(2) How useable is the RTS app for diverse educators working in a range of EC settings?

To determine the effectiveness of the RTS app, we asked educators from five ECEC centres to complete up to 20 randomly activated one-hour records of work activities. We then analysed the generated data. To determine the usability of the RTS app we used a construct approach to user experience testing (Lemon *et al*. 2020). That is, through post-experience interviews/focus groups (as per Maguire's recommendations for HCD user testing), we sought to explore: the acceptability of the app to educators and stakeholders; educators' satisfaction with the app; and the manageability of using the app within an EC context, including any barriers and enablers. This approach aligns with that taken by Chatzitheochari *et al*. (2015) in the development of the U.K. Millennium Cohort time-use diary.

## Materials and methods

### *Ethics*

Ethics was obtained from XXX as well as from EC organizations that required internal ethics approval. All data collected was anonymized. All participants were provided with a retail gift voucher (AUD$25) in recognition of their time.

### *Participants*

Early childhood educators were recruited from five ECEC centres across regional and metropolitan areas, in two Australian States, using convenience sampling. Recruitment occurred at whole-of-centre staff meetings. Staff were provided with a presentation, which included the rationale for the RTS app to make visible EC educators' work; and the need to test the app in the field. The two parts of the project were explained: completion of work activity records in the app; and participation in a follow-up interview / focus group about the educators' experiences of using the app.

A total of 20 educators provided data through the RTS app, of whom 17 participated in a follow-up focus group or individual interview. This number of participants is comparable to Harte *et al*.'s (2017) study of useability of a medical app, undertaken with a user case of 10 participants. Basic demographic information about the educators and their place of work, collected via the app, showed that the educators who contributed to the dataset were a diverse group, in terms of age and experience, gender, cultural background, and qualifications. Participants also held a variety of roles and responsibilities, in their work with different age groups of children (see Table 1).

### *Data collection*

#### *Completion of the RTS time-use diary app*

The participants were asked to download the app and complete the questions after each of two randomly generated notifications, each day for a period of 10 work days. Educators were provided with a user guide, which the research team prepared as a manual to help educator-participants work through the steps and sequence of using the app, and to provide 'trouble shooting' advice. Additional support was available from the research team via a phone helpline and / or through face-to-face visits upon request.

**Table 1.** Demographic details of participants.

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gender | Female | $n = 18$ (90%) | Male | $n = 2$ | | | | | | |
| Age range | 22 – 60 years | | | | | | | | | |
| Cultural and linguistic diversity | Language other than English spoken at home | $n = 5$ | English speaking background | $n = 15$ | | | | | | |
| Qualifications | Degree | $n = 6$ (30%) | Diploma | $n = 12$ (60%) | Certificate | $n = 1$ | Currently studying | $n = 4$ | | |
| Employment status | Full-time | $n = 14$ (60%) | Part time | $n = 6$ (30%) | | | | | | |
| Years of experience | < 1 year | $n = 4$ | 1 – 2 years | $n = 2$ | 3 – 5 years | $n = 9$ | 6 – 9 years | $n = 5$ | | |
| How many services they worked in | One service only | $n = 18$, (90%) | Multiple services | $n = 2$ | | | | | | |
| No. of children responsible for | One group | $n = 11$ (55%) | Two groups | $n = 2$ | Three groups | $n = 2$ | More than three groups | $n = 5$ | | |
| Age of children responsible for | Under 2-years | $n = 3$ | 2 – 3 years | $n = 4$ | 3 – 5 years | $n = 4$ | Mixed ages | $n = 9$ | | |
| Work position | Room leader | $n = 5$ (25%) | Teacher | $n = 4$ | Educator | $n = 7$ (35%) | Assistant | $n = 1$ | Floater | $n = 3$ |

### *Focus group / interviews*

To obtain information about the educators' experience of using the app and any barriers to its implementation, we conducted focus groups with 15 participants and individual interviews with the remaining two participants who were unavailable to participate in a focus group. The focus groups were moderated/conducted by members of the research team and lasted up to one hour. Interviews were conducted face to face or via phone and lasted between 10 and 15 min. Focus groups / interviews were audiotaped and transcribed. Whilst there are methodological differences between focus groups and interviews (for example, the former allow for participants to interact with one another, whilst the latter enables individualized conversations [Silverman and Patterson 2014]), we used the same questions for both methods and generated similar data across both methods.

In keeping with a construct approach to user experience testing (Lemon *et al*. 2020), the focus group/interview questions were designed to probe the educators' experiences with trialling the RTS app. Questions focused on both the content and process of completing the app including educators':

(1) motivation for using the app.
(2) perception of the completeness of the app for capturing aspects of the daily work of educators.
(3) experience of using the app:
    a. technical (e.g. ease navigation; time taken to complete; ability to remember activities/tasks within the 6-minute intervals; challenges and frustrations etc)
    b. process (e.g. ability to respond when notified; any impact on their work from completing the app; organizational and team support/barriers) and user guide.
(4) suggestions for improvement (e.g. changes / gaps / additions required).

## *Data analysis*

### *Time-use diary data*

Data were downloaded from the secure web platform and transferred to SPSS Version 25 for analysis. Descriptive summaries (frequency counts) were used to examine the usage of all domains and subclass categories of work activity, and cross-tabulation tables to examine data combinations.

### *Focus groups and interviews*

Participants' transcribed responses to the focus group and interview questions were collated under each of the four main areas listed above. Themes and patterns in the data were identified through thematic data analysis. To ensure accuracy and consistency, one researcher initially coded the data, then two other team members undertook independent analysis. Analyses were then discussed across the three researchers until consensus about findings was reached.

## Results and discussion

Findings are presented and discussed, first for the time-use diary data and then for the focus groups/ interview data.

## *Insights from the time-use diary records*

Educators provided 546 records of the Primary Activities that they were engaged in during their working day. These were distributed across all of the ten domains and all but six of the 55 subclasses of work activity (see Table 2, column 3). Their records also included 343 entries for Secondary Activities (when educators reported doing another task at the same time as the Primary Activity), indicating that multi-tasking occurred for 62.8% of the recorded hours (see Table 2, column 4).

These frequency counts for each of the pre-coded work activities provide insights into the overall picture of how the educators spent their working day. The majority of educators' time (67%) was spent in direct interactions with children, reported as intentional teaching (10%); being with children (25%); engaging in routine care and transitions (21%), and providing emotional support (11%). The pattern was the same for Primary and Secondary Activities, as shown in Figure 3.

### *Multi-tasking*

These findings for the amount of different types of work activities are consistent with previous studies of ECEC work patterns by Kusma *et al*. (2011), who analysed time-use observations of teachers' work activities, and Harrison *et al*. (2019), who analysed activities recorded by educators using pen-and-paper diaries. However, the information generated by the RTS app is more fine-grained than was possible in these two previous studies. First, by enabling educators to record secondary activities, the RTS app provided detailed information about multi-tasking. Using cross-tabulations analyses, we were able to identify the primary and secondary activities that were completed together. Results showed that 75% of secondary activities (multi-tasking) occurred when educators were engaged with children, distributed across the primary activities of intentional teaching (13%), being with children (27%), routine care/transitions (25%), and providing emotional support (10%).

### *Task rotation*

Second, by setting the RTS app to record work activities in 6-minute time blocks, we were able to examine evidence of task rotation across the hour. Each of the primary activity domains could be mapped against each of the ten possible blocks of time educators could use (6-min, 12-min, 18-min, 24-min, 30-min, 36-min, 42-min, 48-min, 56-min, and 60-min). The distribution of domains by time showed that about one-third (32%) of educators' activities were recorded for only a 6-minute period; half (53%) were recorded for up to 12-minutes (32% + 21% for 12-min); and two-thirds (66%) were recorded as occurring for no more than 18-minutes (32% + 21% + 13% for 18-min). This finding provides new information about the extent of task rotation, which appears to be inherent to ECEC work.

## *Insights from focus groups / interview data*

We present and discuss the findings for the four interview foci (identified above):

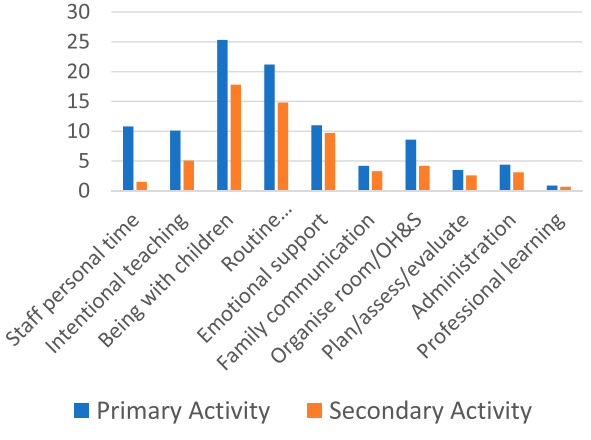


**Figure 3.** Per cent of records for each domain of educators' primary and secondary work activities.

**Table 2.** Total number and per cent of RTS Time-Use Diary records for each activity domain and sub-classes of educators' primary and secondary work activities.

| Domain | Sub-class | Primary Activity | Secondary Activity |
|---|---|---|---|
| 0.Staff personal time | 0.1. Scheduled break | 41 | 6 |
| | 0.2. Other break | 16 | 2 |
| | 0.3. Self-care activity | 2 | 0 |
| | **Total Domain 0** | **59 (10.8%)** | **8 (1.5%)** |
| 1. Intentional teaching with children | 1.0 Problem solving | 8 | 3 |
| | 1.1 Literacy | 10 | 6 |
| | 1.2. Numeracy | 1 | 2 |
| | 1.3 Science/nature | 13 | 5 |
| | 1.4 Social/cultural studies | 3 | 1 |
| | 1.5 Art / craft | 5 | 2 |
| | 1.6 Music / dance | 4 | 2 |
| | 1.7 Media / technology | 0 | 0 |
| | 1.8. Physical / self-help | 9 | 6 |
| | 1.9 Health / wellbeing | 2 | 1 |
| | **Total Domain 1** | **55 (10.1%)** | **28 (5.1%)** |
| 2. 'Being with' children | 2.1 Watch / scan / supervise | 41 | 24 |
| | 2.2 Play with children | 56 | 39 |
| | 2.3 Listen/respond to children | 41 | 34 |
| | **Total Domain 2** | **138 (25.3%)** | **97 (17.8%)** |
| 3. Routine care /transition with children (educator is with the children, interacting or supervising) | 3.1 Hygiene | 26 | 26 |
| | 3.2 Nutrition | 45 | 22 |
| | 3.3 Health | 7 | 4 |
| | 3.4 Sleep / rest | 23 | 12 |
| | 3.5 Organize transitions | 14 | 15 |
| | 3.6 Deal with injury / illness | 1 | 2 |
| | **Total Domain 3** | **116 (21.2%)** | **81 (14.8%)** |
| 4. Emotional support | 4.1 Support positive behaviour | 132 | 17 |
| | 4.2 Mediate conflict | 15 | 8 |
| | 4.3 Comfort child | 16 | 21 |
| | 4.4 Stop unsafe behaviour | 9 | 3 |
| | 4.5 Encourage inclusion | 3 | 2 |
| | 4.6 Other child related | 1 | 0 |
| | 4.7 Support colleague | 3 | 1 |
| | **Total Domain 4** | **60 (11.0%)** | **53 (9.7%)** |
| 5. Family communication | 5.1 Individual face-to-face | 17 | 13 |
| | 5.2 Individual email, phone | 2 | 3 |
| | 5.3 Group / individual written | 4 | 2 |
| | **Total Domain 5** | **23 (4.2%)** | **18 (3.3%)** |
| 6. Organize room / OH&S maintenance | 6.1 Set up | 16 | 4 |
| | 6.2 Pack-up | 11 | 5 |
| | 6.3 Food | 3 | 0 |
| | 6.4 Clean / tidy | 12 | 9 |
| | 6.5 Laundry | 2 | 1 |
| | 6.6 Maintenance / OH&S compliance needs | 3 | 4 |
| | 6.7 Tend to plants / animals | 0 | 0 |
| | **Total Domain 6** | **47 (8.6%)** | **23 (4.2%)** |
| 7. Plan /assess / evaluate | 7.1 Curriculum planning | 7 | 4 |
| | 7.2 Observe / assess child | 2 | 2 |
| | 7.3 Document learning | 9 | 7 |
| | 7.4 Evaluate | 1 | 1 |
| | **Total Domain 7** | **19 (3.5%)** | **14 (2.6%)** |
| 8. Administration | 8.1 Record keeping, roll | 8 | 5 |
| | 8.2 Answer phone / door | 6 | 2 |
| | 8.3 Staff handover / communication | 2 | 2 |
| | 8.4 Staff meeting | 0 | 0 |
| | 8.5 Organizing staffing | 3 | 2 |
| | 8.6 Other | 5 | 6 |

(*Continued*)

**Table 2.** Continued.

| Domain | Sub-class | Primary Activity | Secondary Activity |
|---|---|---|---|
| | **Total Domain 8** | **24 (4.4%)** | **17 (3.1%)** |
| 9. Professional learning and support | 9.1 Self-educate | 0 | 1 |
| | 9.2 Attend PD/in-service | 2 | 0 |
| | 9.3 Support/mentor others | 2 | 3 |
| | 9.4 Receive support / mentoring | 1 | 0 |
| | 9.5 Pedagogical leadership | 0 | 0 |
| | 9.6 Reflection | 0 | 0 |
| | **Total Domain 9** | **5 (0.9%)** | **4 (0.7%)** |
| | **Total Number of Entries** | **546 (100%)** | **343 (62.8%)** |

### *Motivation for using the RTS app for early childhood*

The educators were committed to using the RTS app largely because they believed that the data it generates can be used to raise awareness of the work EC educators do. The following is typical of educators' comments:

> Good idea to do research on what childcare workers are doing. To make people more aware of what we are doing and raise awareness in government/other stakeholders.

### *Completeness of the RTS app for capturing aspects of the daily work of educators*

Participants found the content of the RTS app comprehensive and able to capture their daily work accurately; 16 of the 17 participants did not indicate any activities that they engaged in that were not included in the app. One participant noted that fire drills and medical emergencies were not included, but also that these were very rare occurrences. Given these findings, we are confident that the app captures most work activities.

Nevertheless, the completeness of the records was a concern because recall was difficult for some participants, and others noted that when they were busy, they didn't always include all their activities. Further, several participants reflected that recording one secondary activity did not capture all the multitasking that they engage in. Similarly, the minimum time block of 6-min was considered to be limiting by a few participants because they spent less than six minutes on some activities.

Participant recall can be a challenge in time-use methodology, as can recording all activities (Bolger *et al.* 2003). However, as participants using the RTS app only have to remember the immediate past hour, it is less burdensome than previous time-use methods which have tended to ask participants to record or recall a full day (Ryan *et al.* 2004; Harrison *et al.* 2019). Capturing multi-tasking is also notoriously difficult in time-use methodology (Drago and Stewart 2010), as is the less-studied experience of task rotation. The RTS app time-block parameters (ten 6-min blocks) were set due to technological limits of a smartphone screen and to make entering and analysis of the data manageable. The data generated via the app, although not capturing *everything* educators do, provide a fine-grained and detailed record of educators' work activities.

### *Educators' experience of using the ECRTSTUD app*

*Technical*: The majority (16) of the 17 respondents found using and navigating the RTS app reasonably easy, and quick to complete, reporting it took between 5 and 10 min to enter data for the previous hour and that this got quicker with familiarity. Some participants drew on the 'user guide' to support them and found it helpful. Educators in one service only, requested assistance / support from the research team.

Only two technological issues were noted by participants. One was in relation to the sound volume of the notification beep, which participants commented was too quiet to hear within the EC setting – which can at times be noisy. To remedy this problem, a vibrate function has since

been added to the notification beep. The second technological issue was related to a lack of a 'back-function' on the app, which unfortunately could not be added. However, the RTS app does provide an option whereby participants can correct errors prior to submitting their data.

*Procedural:* All participants reported that they either carried the phone on them or they kept it close by in their room, and that they were mostly able to respond immediately when notified or shortly after on the next reminder notification. Few reported any challenges to completing the app – but one did note that it was 'difficult to fill in as children would come and want to interact whilst entering data – and the children would be the priority so it delayed the time'. Overall, whilst distracting, the notification to complete the app, did not seem to overly interfere with educators' work. Some educators found the randomness of the notifications disconcerting and would have preferred to know when the 'beep' was coming. Further, a few educators expressed a preference for completing the app during their breaks. However, as one astute participant noted, this could lead to biased data:

> If we only report what we've been doing in the 'easy' hours (i.e. when we feel we have time to fill it out), then the data from the most hectic hours where we do the most will not be accessed, and it's important to show how much we really do.

As 'randomness' is an essential element of the RTS time-use diary method – it is not possible to change this. But it does point to the need to assure educators who complete the RTS app that it is understood that notifications will arrive throughout the working day and that some may need to be missed when they are engaged with activities or interactions. The reminders that are sent for notifications not immediately responded to provide a 'window' in which educators can enter data for the identified hour. For the educators who missed notifications, their period of using the RTS app was lengthened. This did not seem to be problematic as all completed their 20-hours. However, four educators stated that towards the end of the data collection period they found completion of the app 'boring' or 'monotonous'. This suggests that when using such apps, researchers need to be mindful that the number of days that educators record their full tranche of data may be prolonged, and they may need incentives to continue – such as positive messages incorporated into the app.

Although all participants in this study had the support of their organization and team members, two worried about perceptions of their colleagues or the parents in their centre, related to the time taken to complete the app, and the use of smartphones while working with children. Thus, an essential ethical consideration in this type of methodology within ECEC settings is organizational permission, and clear communication across teams and with families to inform all stakeholders about why smartphones are being used.

Participants suggested that educators have opportunity to 'just play and practice for a couple of days' with the RTS app. Subsequently, we have developed a 'dummy' version of the app that enables participants to do just that.

## Conclusions and future research

Existing paper-and-pencil self-completed and observer-recorded time-use diary methods have limitations that pre-coded, electronic random-time sampling (RTS) methods can potentially address (Bittman 2016). This paper, drawing on HCD approaches, described the development and feasibility testing of an RTS smartphone app for educators working in ECEC contexts. The paper demonstrates a number of benefits of using this methodology that address some of the limitations and concerns identified in previous research using time-use diaries in educational contexts.

First, in terms of effectiveness, this study has shown that RTS electronic time-use apps enable the collection and safe transfer and storage of useful data about educators' work-related activities. This method, which utilized pre-coded primary and secondary work activities, is time-effective and reduces errors such as may occur when transferring data from pen and paper diaries. From our

experience, the collection of data from two hours per day, using six-minute blocks, over 10 days, provides adequate data; however, for some participants, recording 20 h may be experienced as too long or too 'monotonous' and result in incomplete data. Another concern about our study was the decision to restrict to the period of data collection to educators' working hours. Research by Nuttall and Thomas (2015) and others (Reeves *et al*. 2010; Department for Education 2014) have indicated unpaid work time is common amongst teachers and pedagogical leaders. This, however, is not a limitation of smartphone apps, which can easily be programmed to capture work done outside of contractual hours.

In addition to recording activity data, smartphone apps can be modified to gather other data of interest. In our case, this included the collection of: demographic data; data related to with whom and where the activities occurred; and ratings of participants' perceived experiences of each work hour. Capture of these data along with activity records enabled a nuanced understanding of the work of educators – including diversity of activities, task rotation and multitasking, and responses to different aspects of work – in ways never previously captured by time-use diary methods in ECEC settings.

Second, in terms of usability, our study has shown that RTS apps are acceptable to educators, and manageable within ECEC educational settings. Most educators found the app easy to use – indicating that this method may be less burdensome than traditional methods of time-use data collection reported in previous ECEC studies (Rudd 1999; Harrison *et al*. 2019; Mitchell *et al*. 2019), and potentially contributing to accuracy of completion, which has been noted as a concern in time use research (Bittman 2016). Our findings also suggest that possible concerns over lack of technical skills may not be an issue. The minimal assistance / support requested by participants in this study bodes well for the efficacy of future research using RTS apps in ECEC services, but also points to the importance of 'setting participants up well' in the initial stages of using the app. The participants in this study were all familiar with smartphone technology – educators who lack technological skills may have chosen not to participate. Whilst some potential challenges to using electronic time-use diaries in ECEC settings were identified, the study suggests that these can be readily overcome with careful introduction of the study, open and clear communication, and provision of on-going support.

In regard to the development of time-use apps, our study has shown the benefits of using a HCD collaborative approach. Drawing together specialist content knowledge and technical expertise, as well as including a testing phase, were essential components of the co-design process. Our app was pre-coded using an existing Taxonomy of educators' work. The benefits of pre-coding include ease of use, and the ability to readily modify codes for different contexts. A limitation of precoding is that it restricts participants to what is listed. Moreover, researchers may first need to design their own taxonomy.

Other resources required for the RTS app included 'cloud storage' facilities, and on-going access to specialist technical support to produce the app for different smartphone systems (Apple iOS and Android) and to make modifications when user systems are upgraded. These initial and on-going requirements add to the cost of using apps, which may limit the lifetime of the app.

Overall, our study provides support for the innovative methodology of using smartphone technology in educational research to gain a picture of EC educators' work activities over time. Such tools could be valuable in large-scale research projects for building a comprehensive picture of educators' work in different contexts, and under differing working conditions, and for considering conditions to support the complexity of educators' work.

## Note

1. By 'educators' we mean the range of educators who work in EC settings which can include degree qualified teachers; diploma and certificate qualified educators; and unqualified educators.

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