**The use of mobile-app-enabled training for preschool special educators to provide intervention for young children with autism**

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Synopsis:

There is a shortage of qualified and effective teachers in special education due to turnover, attrition and burnout. Locally, limited resources and high costs have hindered children with special needs from receiving prompt and timely intervention. Without early intervention, children with autism will suffer significantly with poor long term developmental outcomes. A mobile application, *Map4speech*, was developed as a training medium to provide a solution to disseminate intervention skills to teachers in an effective and efficient way. During the session, you will hear about how Behavioural Modelling Training based on Bandura's (1977) social learning theory was embedded as the instructional design in the mobile app to deliver online teacher training. Findings showed an increase in teacher intervention knowledge and techniques in the classroom settings. It highlights the importance of integrating sound adult learning theories which are fit-for-purpose in technology-enabled learning and training.

**INTRODUCTION**

**Global needs of children with special needs and autism**

Autism spectrum disorder (ASD) is a neurodevelopmental disorder commonly diagnosed in early childhood. The prevalence of ASD has increased in many folds since 2002. Currently about 1 in 59 children has been identified with ASD according to the estimates from Centers for Disease Control and Prevention (CDC) in the United States (Baio et al., 2018). In Singapore, there were 4,000 children diagnosed with developmental issues in 2015, a 60% increase from 2,500 children in 2010, according to KK Women's and Children's Hospital and the National University Hospital in Singapore (Tan, 2018). Many children with ASD have symptoms manifested in early childhood, including difficulties in communication and social interaction and having rigid, restricted and repetitive behaviours (American Psychiatric Association, 2013). The disorder brings far reaching and life-long impact to individuals with ASD and their families. Early intervention and substantial support offered to families by social services are important elements in affecting the long term outcomes of children with ASD (Howlin, Goode, Hutton, & Rutter, 2004).

**Preschool special education in Singapore**

In Singapore, early childhood intervention (ECI) programs for young children with disabilities only emerged in the 1980s (Poon & Lim, 2012). There are a total of 21 government funded Early Intervention Programme for Infants and Children (EIPIC) centres, 5 Integrated Childcare Programmes, and Developmental Support (DS) and Learning Support (LS) Programmes for children with different level of developmental needs (SG Enable, 2018). Although the inclusion support for children with ASD was introduced in recent years, there are still many challenges and barriers in this area. Local

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researchers identified several key barriers to inclusion: a shortage of professionals accompanied with low qualifications of special education teachers, no differential instructional contents for students with disabilities, a lack of specialized training and resources, and social stigma for students with disabilities (Poon, Musti-Rao & Wettasinghe, 2013; Yeo, Neihart, Tang, Chong, & Huan, 2011). Although there are pre-employment training (PET) programmes provided for those who are passionate to be preschool educators in early intervention, programmes for Continued Education and Training (CET) are vastly lacking. Effectiveness of early childhood intervention depends upon fidelity, or the degree to which the intervention is delivered as intended (Bumbarger & Perkins, 2008). As such, preschool educators need to improve and maintain their fidelity of intervention beyond the early stage of their initial training. Therefore, it is essential to coach preschool educators for high fidelity of intervention and to support efforts for maintaining high fidelity in intervention through Continued Education and Training (CET).

**A case for Continued Education and Training (CET) using mobile applications**

  **Adult training and the use of technology**. Research findings on adult learning demonstrate that change occurs when evidence-based adult learning strategies are applied in training. These strategies include active learning, provision of multiple learning episodes, opportunities for self-reflections, self-assessment using performance criteria and performance-based feedback (Silberman & Biech, 2015). Ongoing coaching and feedback are the key training components to bring about intervention mastery (Cornett & Knight, 2009). However, training teachers to high fidelity in intervention for children and sustaining their efforts to maintain high fidelity requires extra time and cost, e.g. physical presence of trainers in live coaching and its related travelling time.

There are simply not enough trainers to meet the need (World Health Organization, 2012). Therefore, other solutions must be found. There is a great need to develop and test innovative strategies to provide lower cost coaching support and multiply training resources.

One promising option for coaching support is the use of mobile technology. Mobile technology offers exciting possibilities for enhancing the effectiveness of teacher training, especially in the area of provision of online supervision, coaching and performance feedback (Billingsley & Scheuermann, 2014; Marturana & Woods, 2012; Pianta, Mashburn, Downer, Hamre, & Justice, 2008). The use of a mobile app tool to train teachers using an evidence-based practice has implication for therapists, intervention agencies and governments. It can potentially increase the frequency of timely coaching and training. It may improve the intervention quality while lowering intervention costs.

**What is *Map4speech*?** *Map4speech is* a mobile-app-enabled training program that teaches the user how to conduct naturalistic intervention with young children with ASD to improve their functional communication. It utilizes an adapted, compact curriculum from Project impact (Ingersoll & Dvortcsak, 2010). The key goal is to improve functional communication in young children with ASD. It uses the training framework of Behaviour Modelling Training (BMT; Decker & Nathan, 1985). Behaviour Modelling Training is based on the theoretical work of Bandura (1977) and has five sequential components, i.e., (a) modelling, (b) retention process, (c) behavioural rehearsal, (d) feedback, (e) transfer of training. *Map4sppech* includes 5 mobile app components: instructional videos, small quizzes, a digital game, video

recording and video feedback which correspond to BMT's sequential training components to provide users with step by step training in naturalistic intervention.

**Process of training.** The mobile-app-enabled training includes *eight* learning stages, each of which teaches one to two intervention skills under four curriculum content areas, i.e., (a) follow your child's lead, (b) imitate and animate, (c) make moments for togetherness, and (d) prompt, reward, and expand. In each training stage, there are five application features embedded in the mobile app, i.e., (a) instructional videos; (b) quick check (quiz), (c) interactive game, (d) practice video, and (e) feedback where they facilitate the learning sequence of BMT. This learning sequence is fixed in the mobile app program. Users are to work through the training components and the stages sequentially. They are prevented from accessing other components or stages by locked icons until they pass a certain component/stage. Users were loaned with an iPad. Each iPad was installed with *Map4speech* and also Skype, an application software for free video chat and voice call that was used to provide training feedback for each user (See Figure 1 on *Map4speech* screenshot[1]).

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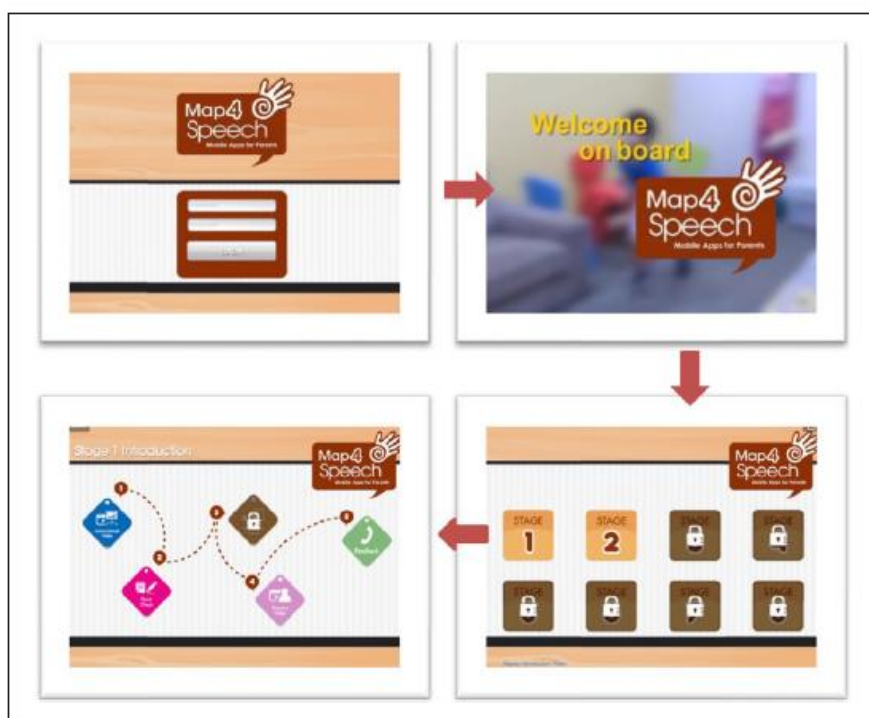[1] Adopted from Law, Neihart & Dutt (2018)

**Figure 1.** Selected screenshots of the main pages of mobile app interface.

## SOLUTIONS AND INTERVENTION

*Map4speech* is a mobile application which was originally developed for parents of children with autism spectrum disorder. It provides high-quality, interactive learning with online performance feedback and coaching. Preliminary results demonstrated the *Map4speech* was effective in training parents to conduct naturalistic intervention to a high level of fidelity (Law, Neihart, & Dutt, 2018). The current study used the same mobile app to provide training for pre-school special educators. The study had 4 aims: to test the prototype training program for teachers, to examine the effectiveness of the app for cross-training program for teachers, to strengthen intervention fidelity among teacher providers in an early intervention preschool, and to evaluate the teachers' acceptability of the training program. The key objective of the study was to examine whether mobile-app enabled training could effectively help teachers improve and maintain the intervention fidelity at 80% or above.

**Methods**

A concurrent multiple baseline design was conducted across four teachers and included three phases: baseline, teacher training, and post training intervention. All phases of the experiment were conducted in the teacher's classroom at a local EIPIC centre in Singapore. The EIPIC centre provides group therapy sessions for children with multiple disabilities, developmental delays and/or ASD. The school timetable only allowed teachers to participate in fifteen-minute intervention sessions with a targeted child, two to three times a week. The total duration for the training and post training periods was estimated at two months.

Four female classroom teachers participated in all 3 phases, except Teacher 4 who could not start Phase 3 because the school term ended after her completion of Phase 2. Teachers had not been exposed to naturalistic intervention in their previous training. Participating children (42-61 months, M= 53 months) were all diagnosed with autism spectrum disorder according to DSM-5 (American Psychiatric Association, 2013) with expressive language level between 3 and 16 months according to Vineland Adaptive Behavior Scales (Sparrow, Cicchetti, Balla, & Doll, 2005).

All phases of the experiment were conducted in the teachers' classrooms at a EIPIC centre that provides early intervention for children with special needs. Each teacher worked individually with their participating child during all phases. A preference assessment was conducted with each child to identify preferred toys that could be used during all phases of the experiment (DeLeon & Iwata, 1996). Each teacher was loaned an iPad containing the *Map4speech* mobile app. Each teacher used the *Map4speech* program during training and post training intervention (Phase 2 & 3).

**Phase 1 baseline.** During baseline, the teacher was asked to engage in free play with her student using preferred toys *without actively doing any intervention*. Each session was two-minutes long and was recorded via the *app.* Baseline sessions for each teacher-child dyad were chosen a priori between 5 and 14 probes (i.e., 5, 9, 11, & 14 probes accordingly). At the end of baseline, teachers were oriented to the mobile app training program. Each teacher participated and rehearsed the learning sequence in Stage 1 under the researcher's guidance during orientation.

**Phase 2 teacher training.** In each stage of Phase 2, teachers participated in the learning sequence independently at their own pace, but were encouraged to complete the video, quiz and interactive game within 1-2 days. There was no limit to the number of times teachers could view the video or try the quiz or game but they had to score 100% in both the quiz and game in order to advance to the next component. At each stage they then practiced their new intervention skills with their student for 15 minutes per day, three times a week. They used the app to video-record two or three 2-minute video clips of themselves conducting the intervention and sent the clips to the researcher via the 3G mobile data network.

The researcher scored the videos using a fixed protocol and then provided feedback to the teachers over Skype to improve their intervention skills. The researcher followed a standard procedure in giving feedback to each teacher after each submission of practice videos (See Law et al., 2018 for details of the protocol). Teachers needed to attain 90-100% fidelity of implementation over two consecutive trials before they could advance to the next stage. The intervention skills across stages were cumulative.

**Phase 3 post training intervention.** Teachers' maintenance of the intervention skills after training was examined in Phase 3. Teachers continued to implement the

intervention procedure with their student independently and recorded their sessions using the app. Feedback was provided only at the teacher's request. No feedback sessions were given to Teacher 2 and Teacher 3. Only one, 12-minute feedback session was given to Teacher 1. Teacher 4 did not participate in Phase 3 because the school year ended.

**Dependent measure - Teacher procedural fidelity.** Ten teacher behavior variables were measured in discrete categorization of occurrence/nonoccurrence in each two-minute practice video (i.e., yes/no) for all phases (See Law et al., 2018 for details of behavioural definitions). Scores of behavior occurrences were converted into a summary score in percentage (0%-100%) and indicated the extent of application of the ten intervention behaviors in each practice video across all phases. Teachers progressively learned intervention skills as they underwent each part of the curriculum. By the end of Phase 2, teachers were expected to demonstrate ten intervention behaviors and reach 90-100% fidelity in order to proceed to Phase 3.

**Inter-Observer Agreement (IOA).** All practice videos and the performance criteria for feedback sessions were scored by the researcher. A trained observer, an experienced teacher, scored at least 33% of all practice videos in each phase to obtain the IOA for teachers' intervention behaviors. She also scored at least 25% of the feedback sessions for the IOA on the performance criteria. The percentages of IOA across teachers ranged between 85% and 98% for teachers' intervention behaviors and between 87.5% and 100% for the performance criteria for feedback sessions across participants.

**Results**

**Teachers' procedural fidelity after training**. Figure 1 illustrates the progress teachers made for learning the intervention skills across phases. All teachers performed below 80% for procedural fidelity across all baseline sessions. Mean percentages for teacher procedural fidelity was at 48% (Range - 30% to 70%). Mean percentages for procedural fidelity for Teacher 1 was 48% (Range - 40% to 60%), Teacher 2 was 54% (Range 40% to 70%), Teacher 3 was 50% (Range - 40% to 60%), and Teacher 4 was 42% (Range - 30% to 50%).

During teacher training, mean percentages for procedural fidelity gradually increased for all four teachers ($M = 65\%$; Range - 40% to 100%). Substantial increases were observed during later stage in Phase 2, TT3 ($M = 75\%$; Range - 70% to 80%) and TT4 ($M = 87\%$; Range - 70% to 100%). Participation in the mobile-app-enabled training resulted in higher mean percentages of procedural fidelity in Teacher 1 ($M = 64\%$; Range - 40% to 100%), Teacher 2 ($M = 66\%$; Range - 40% to 100%), Teacher 3 ($M = 62\%$; Range - 40% to 100%), and Teacher 4 ($M = 67\%$; Range - 40% to 100%). They all attained intervention fidelity of 90-100% by the end of Phase 2.

During Phase 3, eight-six percent of all sessions in Phase 3 were scored above 80% for intervention skills across all teachers.

**Social validity.** At the conclusion of the mobile app program, social validity and treatment acceptability were measured with the Treatment Acceptability Rating Form-Revised (Reimers, Wacker, & Cooper, 1991). Teachers' ratings on TARF-R ranged from 60-70% suggesting that that *Map4speech* was moderately acceptable to teachers.

**Discussion**

This study aimed to evaluate the effectiveness of a mobile-app-enabled training program, *Map4speech*, to improve intervention skills among four preschool special

educators working with young children with ASD. The finding indicates that four teachers had different levels of intervention skills at baseline. However, results demonstrated that teachers increased their intervention skills to an average fidelity of 84-97% after engaging in the mobile-app-enabled training.  Our findings suggest that mobile applications may be a useful means to provide cost effective, ongoing support and training to teachers.

**Implications & and Recommendations for Future Research**. Results of this study support two implications suggested by a previous study that investigated *Map4speech* with parents (Law et al., 2018). First, that mobile applications have potential utility as effective training tools, and second, that behavioral modeling training (BMT) can be an effective pedagogical framework for the design of future training apps.

The *Map4speech* mobile app can serve as a useful prototype to digitally mobilize intervention training and improve access to evidence-based educational practices for teachers, therapists and parents of children with ASD. The use of the mobile app can significantly reduce the physical costs (i.e., money), the organizational cost, the personal cost and the societal cost (Neta et al., 2015). On average, each teacher spent less than 2 hours per week on this mobile-app-enabled training program and intervention. In addition, the mobile app provided flexibility to both teachers and trainers as they could do intervention and training at their time of convenience. This allows trainers to be more productive as they can share their resources with more teachers. Intervention agencies and governments obviously can distribute more resources for children and families with the use of a mobile app tool in response to the increasing number of ASD diagnoses. Needed are larger scale studies and studies that

compare digital trainings for the same concerns to evaluate their relative merits for effectiveness and cost-effectiveness. There is also a need to evaluate the impact of functionality of a digital intervention on its effectiveness as it has obvious implications for the design of future treatments (Fairburn & Patel, 2017). Most digital trainings or treatments are web-based, however, app based interventions have been barely studied (Fairburn & Patel, 2017).

Adult training heavily relies on a good andragogical framework to bring about behavioral or educational change of trainees. There is not a one-size-fits-all andragogy for all contexts and cultures, but Behavior Modeling Training (BMT; Taylor, Russ-Eft, & Chan, 2005) is one framework that has been considerably researched in adult learning contexts. We used and tested it as the framework for the andragogical design of the training program embedded in *Map4Speech*. The framework is systematic in utilizing components such as modeling, retention, behavioral rehearsal, feedback and transfer of training which are embedded in the app. App components provided a standard format and an exact training protocol to ensure consistency and fidelity across training of different individuals (Law et al., 2018). It was pilot-tested to be effective and efficient in raising intervention skills in this study because of both the highly customized, immediate feedback from the quick checks and game, as well as the personalized and focused feedback on specific skills delivery. Currently there is a lack of conceptual models to inform the design and the development of behavioral trainings using a range of technologies that aim to change behaviors and cognitions (Mohr, Schueller, Montague, Burns, & Rashidi, 2014). The challenge that now remains how to design and develop technology as service delivery vehicles for expanding trainings and services for children with special needs.

**Limitations.** This study has several limitations. First, the short duration and low intensity of intervention sessions in this study limited assessment of the effectiveness of teacher training on child outcomes. Second, although teachers were provided with a rationale for the intervention as well as for the study design, their beliefs, assumptions, and expectations regarding approaches to intervention were not assessed prior to the study (Borrelli, 2011). Teachers may have perceived the monitoring and coaching as more oversight rather than support. Due to time and logistic constraints, they were not adequately prepared to understand the need for fidelity and the potential personal benefits to them as interventionists. It is possible that they felt threatened or experienced some dissonance when they did not reach desired fidelity levels as quickly as they expected. Interview feedback from teachers also revealed that they desired a mobile app curriculum with a clearer assessment rubric so that they might benefit more from the formative assessment and the trainer's feedback. Increased workloads towards the end of the school term, and any of the above limitations may have contributed to the slight decline in fidelity scores observed towards the end of the post intervention.

**Conclusion.** Many challenges exist to training preschool special educators in delivering quality intervention for children with autism. Training teachers and monitoring their fidelity in intervention requires extra staff time and cost, but the cost is much less than that of poorly implemented treatment. Findings of this research suggest an innovative strategy to improve fidelity in intervention with young children with ASD. Although scaling studies are needed to test the utility and effectiveness of *Map4speech* across a much larger number of users, initial results suggest that it might be possible to provide high quality training and build capacity within systems effectively and efficiently via mobile platforms.

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