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Teaching and Developing Social and Emotional Skills with Technology

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Abstract

Social and emotional skills refer to a range of interpersonal and life skills that are crucial for virtually all our interactions in everyday life. Teaching and learning such skills has a long history, with a large number of evidence-based programs across many domains such as education, business, medical or therapeutic contexts.

However, very little technology gets used in these programs, despite its potential to enhance and complement the existing approaches. The primary aim of this paper is to provide a foundation and set an agenda for future research on the design of technology that would support, and help teach, social and emotional skills. [[add focus mainly on education]] To this end, we review the literature on social and emotional learning courses within school education, identifying similarities among curricula and shared challenges to successful learning. We then link these to HCI research and the potential for both fields to be mutually enriched. Our key argument is that much existing HCI work can be directly relevant to social and emotional skills learning (SEL) in education (and other domains), but that the topic has been under-researched so far within HCI. We argue how such technology could fundamentally extend and enhance the possibilities available to social skills curricula designers in other domains, and help address some of the key challenges they face [[too much focus on on challenges + need?]] ; as well as pose novel opportunities, challenges and well-motivated practical problems for HCI.

1. KEY ARGUMENT

We argue that while supporting social interactions is a long term focus for HCI, how social and emotional skills are learned, and how this can be supported by technology, is an important but rather underresearched area. We outline SEL for education as an intriguing domain that combines both the need for technology to support some of the greatest challenges, but also opens intriguing research agenda for HCI:

First, SEL programs face the need to better support 'embedding' of the social and emotional skills learned during sessions into everyday life of the students. While the existing approaches, such as homeworks, essays etc., go only so far, drawing on the recent advances in mobile, ubiquitous and sensing technology could make a big difference.

Second, existing curricula bring structure and a list of activities that could be supported by digital technology – allowing tech to be specialised for a specific role, and fit into existing practices, rather than having to take care of all. A similar situation in the related areas of autism or CBT, where the fact that technology support and enhances existing practices helps guide research and pose clear research questions.

2. INTRODUCTION

Social and emotional skills refer to a range of skills that are crucial for our everyday life and healthy development [Weare and Nind 2011; Adi et al. 2007a; Damon et al. 2006]. We define the term broadly here to include skills such as those related to emotional intelligence, interpersonal and communication skills, and also skills such as mindfulness, self-control and empathy. The importance of such skills for personal

competence and well-being is acknowledged both in research and industry [Durlak et al. 2011; Greenberg 2010; Stepien and Baernstein 2006; Barth and Lannen 2011; Carey et al. 2011; Bono et al. 2009]. Social and emotional skills are particularly valued in diverse domains such as education (from kindergarten to university education), leadership, social work, psychotherapy, and medical/clinical settings.

[[This is particularly important for schools as ... societal blah from Cohen2001 and others? around how many students have obvious SEL problems and how teaching could help with these.]]

There are an increasing number of interventions and courses specifically designed to support social and emotional skill learning (SEL) in these areas, substantiated by a large body of peer-reviewed, scientific literature showing that *such skills are teachable* and *interventions can lead to measurable improvements*. For example, Durlak et al. [2011] reviewed the effects of more than 200 SEL interventions within primary and secondary schools, encompassing more than 270000 students. The calculated effect sizes averaged out to an 11% improvement in achievement tests and 10% decrease in classroom misbehaviour, with the effects lasting for at least 6 months after the intervention. However, very little technology gets used in the current curricula, [[and while promising, the effect sizes are still mostly small or moderate, suggesting that further imrpovement are possible [Jones and Bouffard 2012]]] . [[This paper argues that this presents HCI with the potential to explore if and how technology could support such augmentation of social and emotional learning within this domain.]] .

There is also a growing interest in Human Computer Interaction (HCI) on research relevant to teaching or influencing social and emotional skills[1]. In particular, a large body of work has recently focused on autism (e.g., [Escobedo et al. 2012; Porayska-Pomsta et al. 2011; Zarin and Fallman 2011; Tentori and Hayes 2010; Gotsis et al. 2010; Hong et al. 2012]), and on using technology to enhance or facilitate psychotherapy [Coyle et al. 2011; Matthews and Doherty 2011; de Sá et al. 2010; Hancock et al. 2010]. Prior literature also includes smaller scale systems aiming to influence particular social behaviour such as discussion dominance, or rapport (e.g., [Narumi et al. 2009; Piper et al. 2006; Balaam et al. 2011a; Kim et al. 2008b; McAtamney and Parker 2006; Schroyen et al. 2008; Kim et al. 2008a; Toups and Kerne 2007; Kreitmayer et al. 2012; Daily 2010; Munson et al. 2010]). Wider interest in emotional and social skills within HCI is also exemplified for example by CHI workshops on 'Interaction Design and Emotional Wellbeing' (CHI'12), 'Patient-Clinician Communication' (CHI'13) or 'Enabling Empathy in Health care' (CHI'14); as well as a Special Interest Group (SIG) on Work-life Balance.

Given this, it is timely then that the potential of technology to support social and emotional skills training and development is explored in a more thorough way. This paper reviews literature from education to business to medicine , where various forms of social and emotional skills teaching are key, and connects these to existing work in HCI. In doing so, we identify shared aspects and differences across the SEL domains, using these to draw out structure for future work and show potential for mutual enrichment of SEL and HCI research fields. The overall aim is to take the first steps towards a more principled approach to defining a systematic programme of research for HCI in support of SEL.

[1]Research on using technology to support learning in more classical academic subjects such as mathematics, programming, physics or languages has a longer history within HCI, including a number of well-established journals, e.g., Computers & Education. As further discussed in Section 2.3, while we reference selected articles, we do not review this literature in detail as it is mostly focused on declarative, content-based learning, rather than procedural skills-based learning, which is key for SEL.

In particular, we argue that there are core methods and challenges to teaching social and emotional skills which are shared across all domains; and that these raise new opportunities for HCI research to explore if and how state of the art technologies can help address the challenges in SEL, as well as help support SEL more generally. Moreover, we argue that although much of existing HCI work was not, so far, connected to social skills training, it is actually highly relevant and could be beneficial for augmenting existing curricula. We then point to particular opportunities for further research into this topic, outlining the potential of such mutually enriching connections in more detail.

The remainder of this paper is divided into seven sections. The next two sections provide a detailed overview of social and emotional learning (SEL) curricula. We first focus on SEL in schools as an exemplary domain (Section 3), given it has the longest history of both academic research and practical applications, and addresses the widest range of life skills. Section **??** then provides a brief overview of SEL methods and topics within other domains (workplace, medical, psychotherapeutic, and everyday life settings), pointing to relevant reviews and additional literature for each. The following three sections link the SEL literature to particular examples of, and opportunities for, HCI research. Section 4 identifies the key challenges across the existing social and emotional skill curricula from an HCI perspective, Section 5 ties these to potential technology support, and Section 7 maps out the design space for HCI. Finally, Section 8 summarises and concludes the paper.

Results overview. Our review shows that although the interpretation and context of specific taught skills differs across the domains, there are substantial similarities in the methods used and the challenges that face curricula designers; and that these could be supported by technology – see Table 1 for an overview. [[We can now make this much more specific – supporting reflection, collaboration, ...?]] We also outline how all interventions will need to build on the emphasis that social and emotional skills interventions place on experiential learning. This then brings the related aspects of the need for substantial *practice* and *cueing reflection??*, the key importance of the *transfer of learned skills* from facilitated sessions into everyday real world settings and the *need to motivate and engage* learners.

We use these learning principles as an initial structure to guide designers and researchers in thinking about ways to support SEL in each of the diverse domains; and show how this fits well with, and could easily benefit from, existing HCI work on ubiquitous computing, social signals processing, behavioural change, and "into the wild" research (see Table **??** on page **??**).

Multi-level paper structure. The text is structured to allow for several ways in which readers can approach the paper. We provide a detailed overview of the SEL literature as well as the examples of potential technology support. This is meant to serve as an initial 'guidepost' for readers interested in learning more about the specific subtopics, and as an argument base for the interpretations we make, but could be deemed as too detailed for others. For this reason, we keep all such detail in the third level subsections (e.g., 2.4.X or all third level subsections in section 5) and the paper can be read also by skipping these entirely. Similarly, readers interested only in the key implications for HCI can jump directly to Sections 4 to 7, leaving out the review of SEL literature.

	Education (Sections 2.1 to 2.5)	Workplace settings (Section 3.1)	Medical settings (Section 3.2)	Therapeutic settings (Section 3.3)	Everyday settings (Section 3.4)
Topics and skills taught	**Four core areas:** • identify and understand emotions • self-control strategies • communication skills • dealing with conflict and problematic situations	**Diverse topics around 'emotional intelligence'** • leadership skills • cooperation and communication skills • self-management and planning • other personal skills, e.g., via coaching	**Self-oriented skills:** • stress, coping and life-style management **Interpersonal skills:** • patient-clinician communication e.g., motivational interviewing • empathic skills	**Therapy process (supporting the patient):** • wide range of social and emotional skills depends on the patient's issues **Training and skills development of therapists:** • developing detailed self-awareness • active listening and empathy skills • techniques and approaches of the therapeutic approach	**Diverse topics:** • non-clinical interventions, e.g., interpersonal skills courses, mindfulness based stress reduction • life-coaching and other commercial consultation • self-driven change
Methods	**Shared across domains** **Key methods,** based on **procedural learning** approaches: • supporting personal experience and opportunities to try out the skills in practice • using model situations, role-plays • slowly building to more complex situations, preferably based on real-world experiences of the learners • feedback from others is key during practice				
Challenges	**Shared across domains** **Four learning principles** (in bold) and the associated key **challenges**: • providing timely **feedback** (currently post-hoc, coming from trainer/peers) • creating opportunities for real-world **practice** (currently limited mostly to in-session training) • **embedding learnt skills into everyday life** (very little is possible for curricula designers at the moment) • facilitating learners' **engagement and motivation**				

Table 1: Overview of the key distinctions and similarities

3. LIFE SKILLS COURSES' CONTENTS WITHIN EDUCATION

This and the next section outline the contents of existing social and emotional skills courses and curricula in domains outside of HCI. We analyse (i) what are the core skills that get taught; (ii) how existing curricula approach this; and (iii) what challenges they face. The goal here is to build an overview of what gets taught and how across the domains, and then use this structure to outline the potential for HCI research (sections 4 and 5). We first outline the reasons why we chose SEL for schools as an exemplary domain (section 3.1), and describe the literature review methodology (section 3.2). We then present the *methods* used in teaching of social skills in education (section 3.3) as well as the key *topics* that get taught (section 3.4), including specific examples from various curricula.

3.1. SEL in schools as an exemplary domain

Social and emotional learning in education is a particularly interesting domain for several reasons, all suggesting that the field can be considered relatively mature, with a number of well-researched and evidence-based approaches.

First, skills taught in school-based curricula are those that have been identified by psychologists and educators as crucial not only to development in childhood and teenage years, but more importantly as key skills for adult life [Greenberg 2010]. They also focus on a large span of ages, from kindergarten to high-school education. As such, it to some extent encompasses the core set of skills needed in other life skills domains that tend to emphasise particular subsets of social skills, and consider many others to have already been developed during childhood and thus available.

Second, SEL has more than 20 years' history of peer-reviewed programs, which have already been deployed to hundreds of thousands of pupils. For example, Durlak et al. [2011] reviews 213 programs intervention studies encompassing more than 270000 students of all ages, with the interventions conducted over several years. Some studies have their effects tracked for even longer periods of time, as is the case for Muennig et al. [2009] who recently presented a 37-year follow-up study on the results of a randomized controlled trial conducted in 1962. Moreover, federal programs support further uptake of such curricula in the US.

Third, recent academic reviews analyse the evidence-base for the effectiveness of SEL programs and find measurable and significant positive effects of SEL in randomised trials, e.g., [Durlak et al. 2011; Greenberg 2010; Weare and Nind 2011]. In particular, the social and emotional skills curricula lead to improvements in the academic performance and the skills actually taught (e.g., Durlak et al. [2011] report average of 11% improvement in achievement tests, 25% in social and emotional skills in the 207 SEL interventions reviewed), as well as positive impacts on many other aspects of behaviour such as mental health [Adi et al. 2007a], violence prevention [Mytton et al. 2006; Adi et al. 2007b], conflict resolution [Garrard and Lipsey 2007], and bullying [Vreeman and Carroll 2007]. For more detail see e.g., Weare and Nind [2011] who provide a meta-review of 52 reviews in this domain, concluding that the interventions "had wide-ranging beneficial effects on individual children and young people, on classrooms, families and communities and on an array of mental health, social, emotional and educational outcomes".

[[Fourth, although the existing results are promising, there is still space for improvement, and strong push to do so from the SEL community – which is also why we argue HCI might be useful in this domain.]]

3.2. Literature review methodology

A large number of systematic reviews of SEL literature already exist, mainly with the focus on meta-analyses of measurable effects and long-term impacts of the curricula (e.g., [Durlak et al. 2011; Weare and Nind 2011; Adi et al. 2007a; Greenberg 2010; Elbertson et al. 2009; Payton et al. 2008]). We build on these and approach the topic with a complementary HCI perspective in mind, aiming to draw out processes, methods and topics commonly used within curricula, and identify the challenges the curricula designers currently face.

As such, we analysed the contents of selected curricula, in addition to following references cited by the academic reviews above. This analysis was done by first creating summaries of individual curricula, collating these in mindmaps to draw out related topics, methods and approaches, and finally iteratively identifying the common aspects across curricula and domains. Given the large number of available curricula for the educational domain, we based our review on a set of curricula selected by 'Collaboratory for Academic, Social and Emotional Learning' (CASEL)[2], which is a non-profit organisation supporting research and application of social and emotional learning in education, co-founded by the leading figures in the academic field.

In particular, we drew on curricula identified in two CASEL 'guides': CASEL [2003] guide reviews 80 SEL programs selected by a rigorous procedure, highlighting 22 of these as particularly well-designed. Each of the 80 programs is described, rated on 15 aspects and linked to academic literature evaluating its effects. The newer version of the guide, CASEL [2013], focusses primarily on preschool and elementary school programs, recommending 23 programs. We first systematically analysed the descriptions of all programs in both guides, and continued with more detailed examination of the programs highlighted in either version of the guide (i.e., 34 programs altogether[3]), as well as the academic literature available for each of these programs as referenced in the guides, as long as it was accessible through the libraries of three major universities (yielding 66 academic articles altogether). We also included any course materials and descriptions of the programs that were available on the internet. Finally, we included a number of books on creating SEL curricula in the context of schools [Maree et al. 2007; Elias 1997; **?**; **?**]

3.3. Methods for teaching SEL in education – experiential learning

Curricula share the understanding of social and emotional skills as highly complex abilities, based on subconscious processing [Ambady 2010; Lieberman 2000]. As such, social and emotional skills are based on *procedural* rather than declarative knowledge [Kruglanski and Higgins 2007, p.288], and thus require experiential approach to be learned. Moreover, the key ability of most social and emotional skills is to be able to react appropriately even within 'hot' moments, that is situations when the learner is overwhelmed with emotions, the importance of the situation, or just has a very short time to react (e.g., heated conflict). During such moments, the ability of conscious, analytical thought is often diminished [Wyman et al. 2010; LeDoux 1998], again emphasising the need for learning skills that operate on a procedural basis.

Curricula thus use predominantly active instructional techniques drawing on skill-based and experiential approaches. They employ a wide range of methods such as modeling, role-play, performance feedback, dialoguing, positive reinforcement, vignettes, play and games; but also approaches such as portfolios, expressive arts, exhibitions, or group projects – see also Fig 1 for an extended list. Through these methods, curric-

[2]`http://casel.org/`

[3]Eleven programs selected in CASEL 2013 guide were already selected in the 2003 edition, leaving twelve newly described ones, leading to 34 programs altogether (22+12).

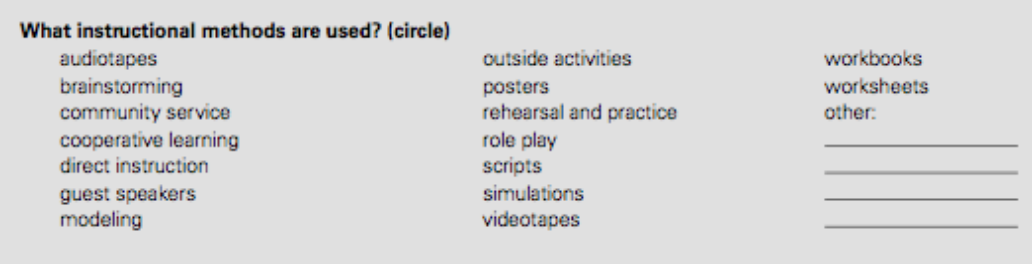

Fig. 1: Instructional methods used in SEL courses (modified from [Elias 1997, p.109])

ula aim to include extensive examples and opportunities for personal experience and practice, combined with extensive feedback on behaviour and progress. For example, when teaching a complex skill such as emotional awareness, curricula would break the skill down into 'digestable' bits , focusing first on simple model situations and exploring these by role play (e.g., specific situations such as disagreement with a peer), and only then slowly building up to more complex situations. Repeated practice and extensive feedback from the trainer and peers are critical components in every step of the process.

Curricula are clear that the methods used must be developmentally appropriate for the age of the children, and the skills learned. For example, incorporation of fantasy play or puppets as role models and curricula protagonists has been very successful for younger children (e.g., kindergarten to K-3), who can relate to them easily [Webster-Stratton and Reid 2004]. In contrast, group discussions, journal writing or workshop activities are more commonly used with older children and teenagers [**?**]. However, specific key methods such as role-playing, modeling, positive reinforment, or direct and indirect instruction are used throughout in various guises.

The core of most curricula is a set of SEL focussed, structured classroom lessons. However, once a skill is mastered within the lessons, the key emphasis is then on its *transfer* out of the classroom into everyday contexts to promote maintanance and generalisation. Curricula appreciate the need to support opportunities for the learners to practice their new skills in real life situations outside of the classroom, but have limited strategies to do so [Jones and Bouffard 2012]. Among the commonly used methods are activities to increase awareness and remind learners about their skills on the school grounds (e.g., posters around the school); attempts to enlist the help of their social networks outside of the learning environment (e.g., workshops with or letter campains parents asking them to help reinforce the learning at home); as well as various home exercises for students.

[[This is probably not good enough at the minute – would need one paragraph about the parent/community involvement in more detail, if saying that this is an increasing focus or similar blah. Additionally, this combined the embedding into school life, and embedding into everyday, which is probably not what we want?]]

3.3.1. Common theoretical models. There is no universally agreed on theoretical model among the existing SEL curricula [Payton and Wardlaw 2000] that would ground the learning process. Instead, curricula build on several 'competing' theories that each have robust evidence of positive effects[4]. Some of the most prevalent theoretical approaches are: (i) systems theory, which views SEL learning as embedded in broader

[4]This is similar to psychotherapy domain, where a number of schools co-exist in parallel, each building on different theoretical groundings, but exhibiting similar positive effects.

SEL Competency	SEL Skills Related to Each Competency
Self-awareness	▪ Label and recognize own and others' emotions. ▪ Identify what triggers own emotions. ▪ Analyze emotions and how they affect others. ▪ Accurately recognize own strengths and limitations. ▪ Identify own needs and values. ▪ Possess self-efficacy and self-esteem.
Self-management	▪ Set plans and work toward goals. ▪ Overcome obstacles and create strategies for more long-term goals. ▪ Monitor progress toward personal and academic short- and long-term goals. ▪ Regulate emotions such as impulses, aggression, and self-destructive behavior. ▪ Manage personal and interpersonal stress. ▪ Attention control (maintain optimal work performance). ▪ Use feedback constructively. ▪ Exhibit positive motivation, hope, and optimism. ▪ Seek help when needed. ▪ Display grit, determination, or perseverance. ▪ Advocate for oneself.
Social awareness	▪ Identify social cues (verbal, physical) to determine how others feel. ▪ Predict others' feelings and reactions. ▪ Evaluate others' emotional reactions. ▪ Respect others (e.g., listen carefully and accurately). ▪ Understand other points of view and perspectives. ▪ Appreciate diversity (recognize individual and group similarities and differences). ▪ Identify and use resources of family, school, and community.
Relationship management	▪ Demonstrate capacity to make friends. ▪ Exhibit cooperative learning and working toward group goals. ▪ Evaluate own skills to communicate with others. ▪ Manage and express emotions in relationships, respecting diverse viewpoints. ▪ Communicate effectively. ▪ Cultivate relationships with those who can be resources when help is needed. ▪ Provide help to those who need it. ▪ Demonstrate leadership skills when necessary, being assertive and persuasive. ▪ Prevent interpersonal conflict, but manage and resolve it when does occur. ▪ Resist inappropriate social pressures.
Responsible decision making	▪ Identify decisions one makes at school. ▪ Discuss strategies used to resist peer pressure. ▪ Reflect on how current choices affect one's future. ▪ Identify problems when making decisions, and generate alternatives. ▪ Implement problem-solving skills when making decisions, when appropriate. ▪ Become self-reflective and self-evaluative. ▪ Make decisions based on moral, personal, and ethical standards. ▪ Make responsible decisions that affect the individual, school, and community. ▪ Negotiate fairly.

Fig. 2: Exemplary list of skills relevant to individual competencies (from `http://www.gtlcenter.org/sel-school`)

community and aims to systematically create a comprehensive climate for teaching SEL in the class but also school and local communities more broadly; (ii) psychoanalytic theory that work with how conscious as well as unconscious (unrecognised) emotions shape how we act or learn, and who we are; and (iii) cognitive behavioural theory as base for primary prevention and the core skill based techniques such as modeling or role-play [Maree et al. 2007, p.65]).

However, there is a considerable overlap among these models in the compentencies to be learned (as described in the next section), as well as a shared set of guidelines on what makes curricula effective. In particular, curricula should take a wide scope (both in terms of methods and skills learned), build on a clear theoretical framework (although the selected theory differs across curricula), use a comprehensive approach intergrating affective, cognitive and behavioural dimensions, and promote generalisation (e.g., [Elias 1997, p.119]). [[In particular, piecemeal programming efforts are not as effective – get good references (e.g., [**?**, p.13].]]

[[Outline the theoretical background of PATHS, Incredible Years and RULER. What does this mean for technology?]]

3.4. Goals of SEL learning

A set of five core competencies is widely accepted within the educational community [Zins and Elias 2007; Durlak et al. 2011; CASEL 2003; 2013] as a good description of the general goals shared by most of the existing curricula, despite the range of underlying theories. We quote these compentencies and their brief descriptions as per Durlak et al. [2011]:

— **Self awareness:** The ability to accurately recognize ones emotions and thoughts and their influence on behavior. This includes accurately assessing ones strengths and limitations and possessing a well-grounded sense of confidence and optimism.
— **Self-management:** The ability to regulate ones emotions, thoughts, and behaviors effectively in different situations. This includes managing stress, controlling im-

pulses, motivating oneself, and setting and working toward achieving personal and academic goals.
— **Social awareness:** The ability to take the perspective of and empathize with others from diverse backgrounds and cultures, to understand social and ethical norms for behavior, and to recognize family, school, and community resources and supports.
— **Relationship skills:** The ability to establish and maintain healthy and rewarding relationships with diverse individuals and groups. This includes communicating clearly, listening actively, cooperating, resisting inappropriate social pressure, negotiating conflict constructively, and seeking and offering help when needed.
— **Responsible decision making:** The ability to make constructive and respectful choices about personal behavior and social interactions based on consideration of ethical standards, safety concerns, social norms, the realistic evaluation of consequences of various actions, and the well-being of self and others.

However, these core goals comprise of complex, interrelated abilities and it is not possible to teach any of these directly. Instead, each curricula helps learners move towards this ultimate goals by progressively learning smaller, 'molecular' skills. See Figure 2 for a mapping of individual skills to individual competencies.

3.5. How are the competencies taught

To exemplify how the competencies are taught within curricula, and in which order, we draw out a four sets of such molecular skills that consistently appear in most of the curricula, and across all age ranges.

(1) identifying and understanding emotions (own and of others);
(2) managing own emotions;
(3) developing communication and relationship skills;
(4) dealing with conflicts and problematic situations.

Each topic thus subsumes a number of simple situations or skills (e.g., being able to identify when becoming angry) and ways to train these (e.g., training learners to notice physical changes in their bodies). Moreover, these topics build on each other in a sequential manner. The ability to identify and understand emotions is a key pre-requisite for managing own emotions (without knowing one's own emotions, one cannot control them), which is in turn needed for keeping relationships (appreciating the perspective of another, not jumping to conclusions) etc. As such, they are taught in the order as shown at Figure 3.

We describe each topic in more detail in a respective subsection below, illustrating the descriptions with examples of specific activities from selected curricula. Our goal is twofold: to provide an initial 'feel' for how such skills are taught in this domain; and to set up explicit examples that can be used in later sections to tie some of the existing HCI research to the approaches presented here. Figure 4 then maps how the four topics contribute to the goals above.

3.5.1. Identifying and understanding emotions. The ability to identify and understand own and others' emotions is a prerequisite of most other social and emotional skills. A key goal is developing the emotional awareness of learners, which is the ability to differentiate, name and notice subtle changes of emotions. Curricula[5] aim to train a practice

[5]Curricula including content on identifying and understanding emotions are: Caring School Community, I can problem solve, Life Skills Training, PATHS, Peace Works, Quest (Violence Prevention Series), Open Circle, RIPP, Responsive Classroom, Second Step, SOAR, Social Decision Making and Problem Solving Program, 4Rs, Competent Kids, The Incredible Years Series, Michigan Model for Health, MindUP, RULER, Social decision making, Steps to respect, Too Good For Violence. **21 in total**

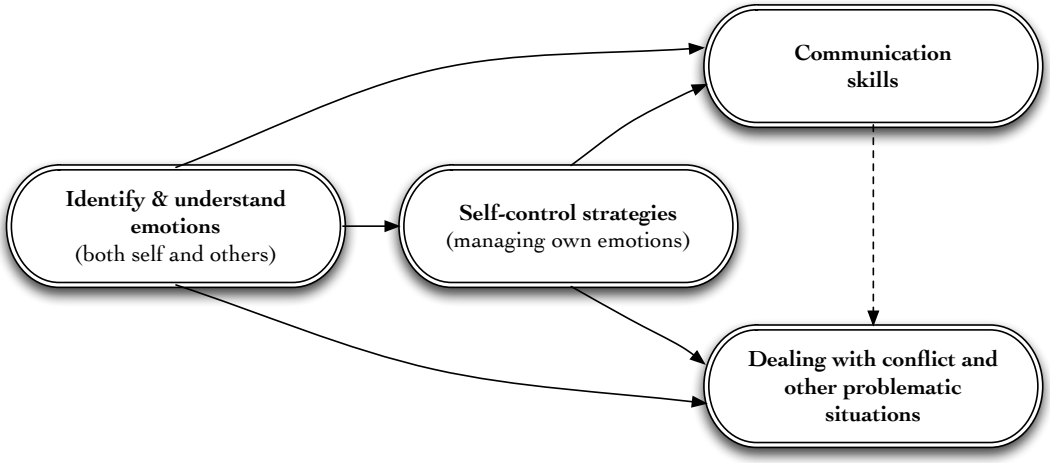

Fig. 3: Summary of the identified key topics in SEL in education and their dependencies.

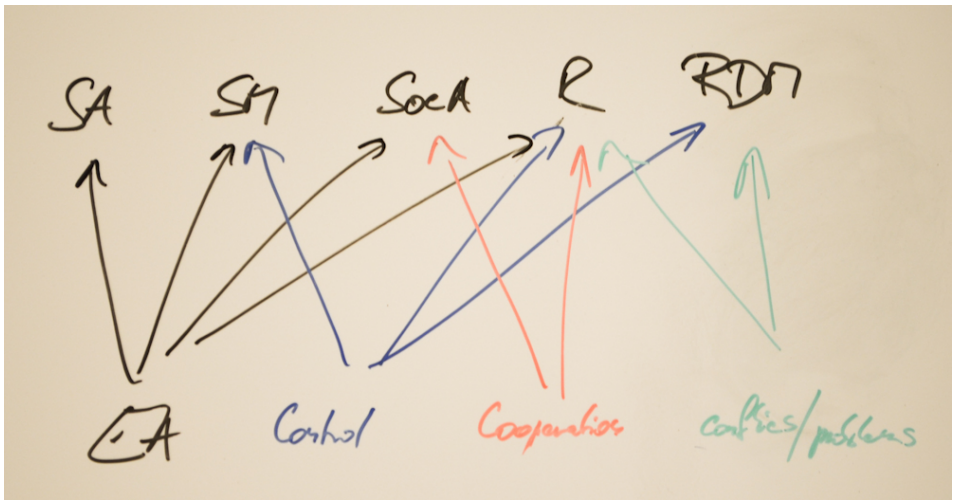

Fig. 4: Mapping of topics to core competencies

of internal reflection, leading to continuous exploration of how we and others feel. Emphasis is also placed on making the distinction between acknowledging a feeling, and acting upon that feeling/urge.

In particular, some of the curricula build on language usage, and especially on how use of language affects our thinking processes. Various exercises focus on developing the ability to identify emotions in both oneself and others, helping learners to become more reflexive and self-aware. As an example, the PATHS curriculum includes physical "Feeling Faces" cards, which the child learners use to signal their current emotional state throughout the day [Kam et al. 2004; Domitrovich et al. 2007]. Similarly, RULER curriculum uses popular stories to exemplify particular emotions, or draw out distinctions among subtle variants of a specific one [Reyes et al. 2012]. Another approach aims to support self-reflection by exploring and understanding how our bodies are affected by experiencing particular emotions. For example, children are helped to

recognize their own feelings by checking their bodies and faces for 'tight' or relaxed muscles, frowns, smiles, and sensations in other parts of their bodies such as butterflies in their stomachs. Matching the facial expressions and body postures shown on cue cards helps the children to recognize the cues from their own bodies and associate a word with these feelings [Webster-Stratton and Reid 2004]. Emotions of others are explored through the ways in which they affect the tone of voice, body language etc. This is often incorporated as a game, e.g., developing the 'detective skills' to find out how others feel. Repeated use of similar activities aims to help learners think more often about how they, and others, might feel in various situations.

3.5.2. Self-control strategies. Self control and management of own emotions is a key aspect present in many curricula[6] and the techniques used to developed self control build on emotional awareness.

Various strategies and exercises aim to help participants to relax and/or calm down once a strong feeling is recognised. These are often based on various physiological exercises such as muscle stretching and deep breathing techniques. Other strategies draw on verbal labelling, building on psychology and neuroscience findings showing that the act of consciously labelling an emotion by name (rather than "just" being aware of it) facilitates higher cognitive control over the emotional state [Greenberg 2006; Reyes et al. 2012]. Exercises training explicit acknowledgement of emotions, as well as thinking about what could be their cause, are often used. Specific strategies for anger management are particularly common, often combining both verbal labelling and physical relaxation exercises. An example is the "Turtle technique" [Robin et al. 1976], which is still used in a number of curricula (e.g., PATHS). In this technique, children are taught to "withdraw into their shell" (by pulling their arms and legs close their body and closing their eyes) at specified occasions such as when they feel increasingly angry. This is followed by a relaxation phase, where specific muscle groups are tensed and released. Once this technique is mastered, children discuss and appropriate alternative strategies of dealing with stressful situations, now that they are able to consciously reflect and react to them.

3.5.3. Communication skills. Another set of activities focuses on building good communication skills and supporting positive interactions with others[7]. The skills taught here aim at supporting respectful empathic communication and thus implicitly facilitating friendship relationships, and an ability to collaborate and avoid conflicts that could otherwise occur through misunderstanding.

The emphasis is on teaching active listening, which is then used to facilitate teaching empathy. Other teaching strategies also focus on training of specific communication skills (e.g., giving and accepting compliments). Exercises can include games to: induce collaborative activities; practise active listening, e.g., through listening to someone telling a story and then trying to rephrase it with as many details as possible; and disagree respectfully. These can include ways to subtly reframe a message into a form which is not threatening, such as in Aber et al. [1998] where students are taught to acknowledge the potential mismatch between their and the other's perception of the

[6]Life Skills Training, Lion's Quest, PATHS, Peace Works, Productive Conflict Resolution Program , Quest (Violence Prevention Series), Open Circle, RCCP, RIPP, Responsive Classroom, Second Step, SOAR, Social Decision Making and Problem Solving Program, Teenage Health teaching Modules, 4Rs, Al's Pals, Competent Kids, The Incredible Years Series, MindUP, Positive Action, RULER, Steps to respect, Too Good For Violence. **24 in total**

[7]While implicit in many others, this aspect is explicitly highlighted within the following curricula: Michigan Model for Comprehensive Scholl health Education, Peace Works, Open Circle, RCCP, Responsive Classroom, Second Step, SOAR, Tribes, Al's Pals, The Incredible Years Series, MindUP, Positive Action, Steps to respect curricula. **13 in total.**

situation (e.g., preferably saying ”It seems to me you are not listening now.”, rather than “Why aren’t you listening to me!”).

3.5.4. Dealing with conflicts and problematic situations. Problem solving strategies and conflict management are the final topics of most curricula[8]. Violence prevention is commonly an important additional goal, as many of these curricula are designed for schools and neighbourhoods with a high prevalence of aggression and weapon use.

Students are often taught a particular structure of reacting to a problematic situation or a conflict. A key approach is to help students process the situation on a cognitive level, despite the fact that conflicts tend to ignite strong emotions. For example, the PATHS curriculum includes a “semaphore”, where the sequence of red-yellow-green indicates a ”stop-think-proceed” process [Kam et al. 2004; Domitrovich et al. 2007]. Such structured sequences always include and emphasise a goal setting and evaluation phase. Moreover, curricula aim to teach children and teenagers to recognise which conflicts might have arisen from misunderstanding, with perspective taking exercises forming the core approach. An example are workshops focusing on win-win negotiation (e.g., in RCCP) and providing suggested sequences for steps to take during disagreements (e.g., in Incredible Years).

3.5.5. Differences across grades. [[Do we want to highlight anything here?]]

[8]Michigan Model for Comprehensive Scholl health Education, PATHS, Peace Works, Productive Conflict Resolution Program, Quest (Violence Prevention Series), Open Circle, RCCP, RIPP, Responsive Classroom, Second Step, SOAR, Social Decision Making and Problem Solving Program, Tribes, 4Rs, Al’s Pals, I Can Problem Solve, Competent Kids, The Incredible Years Series, Positive Action, Social decision making, Steps to respect, Too Good For Violence. **22 in total**

3.6. Current challenges for SEL in schools

3.6.1. Drawing out key approaches/techniques?. [[Molecular, molar and global concepts to be taught]] .

[[Add things around social information processing as key –Zins,p.83]] [[Also *"R–reflective capacities or an enhanced awareness of ourselves and others–is the foundation for all learning and development;Reflective capacities involve personal and an interpersonal component that provide a person with the ability to understand and learn from social emotional experience"* [Cohen2001]]]

The curricula take some or all of the three approaches outlined below, following [**?**, p.81]: *"The first is that specific intervention goals may entail an emphasis on particular skills. For example, many SEL programs consider the prevention of violent and antisocial behavior a top priority, and therefore emphasize conflict resolution and related skills. The second approach is to emphasize skills that are likely to generalize across settings and situations. Self-management skills, for example, involving planning and deliberation, self-monitoring and self-reflection, are applicable to practically all domains of life. Some learning skills, including strategies for acquiring knowledge and learning from feedback, also are likely to generalize. The third approach is to capitalize on implicit or informal learning, such as taking advantage of the everyday problems and disputes as they arise in the classroom to help children develop perspective taking and communication skills; or through infusing social and emotional learning into the teaching of traditional subject matters such as literature or history. "* [Zins]

3.6.2. Limitations of the current approaches:. *"* **Limited staff training** *Teachers typically receive little training in how to promote SEL skills, with peer-conflict, or address other SEL-related issues (Lopes, Mestre, Guil, Kremenitzer and Salovey, 2012; Kremenitzer, 2005). Pre-service teacher training includes little attention to these issues beyond basic behavior management strategies, and little in-service support is available on these topics, particularly through effective approaches like coaching and mentoring. Staff members other than teachers receive even less training and support, despite the fact that cafeteria monitors, bus drivers, sports coaches, and other non-teaching staff are with children during many of the interactions that most demand effective SEL strategies and skills.*

Sole Focus on Classroom – Embedding to other activities at school *Most SEL programs focus solely or primarily on what goes on in the classroom, but SEL skills are also needed on playgrounds, in lunchrooms, in hallways and bathroomsin short, everywhere. These non-classroom contexts provide vital opportunities for students to practice their SEL skills. Across ages, issues like sharing, entering into social situations, and social inclusion and exclusion occur frequently in parts of the school campus outside of classrooms."* [[Jones and Bouffard 2012, p.7]] *"Perhaps most importantly, and often overlooked, is the fact that SEL programs are rarely integrated into classrooms and schools in ways that are meaningful, sustained, and embedded in the day-to-day interactions of students, educators, and school staff. "* [[Jones and Bouffard 2012]]

" **Embedding in community** *Lastly, the efforts of school-based practice falter because educators are not committed to being ongoing, vital SEL role models. SEL involves not just the students in schools but also the adults in their lives: teachers, parents and the wider community. If these adults lack social and emotional competency, children will quickly notice the discrepancy between behaviors that the adults advocate for children and the actions that the adults take themselves. Unfortunately,little attention has been given to the importance of adults being social-emotional learners themselves. In fact, most colleges and departments of education do not include SEAE as a vital and explicit dimension in teacher education. But there is growing interest in this area and it represents one of the most important next steps that we can and need to take."*

[[Maree et al. 2007, p.71]] [[Posters not effective [Cohen 2006]]]
"Many SEL efforts fail because long-term, coordinated plans and school-home partnerships are not developed." [[Maree et al. 2007, p.70]]

[[Despite the extensive search, we have not found literature describing the challenges that are faced by the learners themselves. While this is to some extent presented as inherent in the existing curricula that are designed to support]]

4. SUMMARISING SEL – FOUR LEARNING PRINCIPLES AND ASSOCIATED CHALLENGES

The previous section outlines the general agreement on core skills and general approaches to teaching these; albeit interpreted specific to contexts (theories) and age ranges of pupils/teachers. In particular, all these teaching methods and approaches draw on a common dependence on procedural learning – see Table 1 on page 4 for an overview.

4.1. Four learning principles

Based on these similarities, we draw out a set of four 'learning principles', with each principle pointing to particular challenges to social and emotional skills learning. We frame these principles with HCI research in mind, distinguishing them here in order to highlight particular issues that HCI designers and researchers could consider supporting, as part of adressing the specific topics (such as self-awareness etc).

In this sense, they provide a set of perpendicular aspects, common for all the skills described earlier. By pointing to particular approaches and methods, it is our hope they help to outline more clearly how social and emotional learning could tie in with, and benefit from, HCI interests, guiding future work on this topic.

We emphasise however that they should not be understood as independent, reified concepts. They are obviously interrelated and dependent on each other, and it is likely that any real-world system will draw on multiple if not all of these aspects, although perhaps focusing on some more than the others as relevant.

We list the four principles below, and then discuss each in turn:

(1) providing cues for reflection;
(2) facilitating practice;
(3) embedding and transferring skills into everyday situations;
(4) supporting motivation and engagement of the learners.

Supporting the reflective abilities. [[Base on the experiential learning as a main concept]] As social and emotional skills are very complex and challenging for learners to track easily by themselves without external support, all curricula facilitate various ways to give the learners feedback on their behaviour. However, providing timely feedback is difficult. Within the facilitated training sessions, the expert trainer or peers serve as the key source of feedback. A challenge though is that this feedback mainly happens in a post-hoc manner, and often from unguided recollection of what happened during the practice. Moreover, the ratio of trainer to students commonly means that learners get feedback mostly from their peers, who are not trained or particularly skilled in what is taught. Outside of the facilitated sessions, any form of feedback is virtually impossible, and often ends up relying on the student's self report of their own attempts to practise when they come back to the facilitated session.

— *"Promoting reflective capacities, that is, an ability to read ourselves and others, is the first core concept of effective SEL programs. It is the foundation for all learning."* [Cohen2001]
— *"Experiential learning... copy and paste some stuff from there?"* [Moon]
— *"Students need opportunities to problem-solve with others and to examine what worked and did not work in those interactions and collaborations. To develop their self-knowledge and capacity to deal effectively with others, students need a range of opportunities to apply decision-making and problem-solving skills to various situations. The educational goal becomes more than the end product, final presentation, or project; it includes an examination of how the student (and her peers) worked together. What behaviors and attitudes helped the group; which hindered? What are the characteristics of effective and ineffective collaborators in group situations? What are*

the strengths each person brings to a cooperative learning project? Through varied experiences, students can develop the skills and habits that will help them beyond school and throughout life." [Pasi, p12]

— *"Many of these skills are basic to human functioning, so they begin to appear in rudimentary form in infancy. As children get older, they apply these skills to increasingly complex situations and learn to differentiate, label, and integrate them. Even in adolescence, skill development continues, primarily through the feedback, reflection, learning, and growth that result from new experiences. Helping students develop and coordinate skills in emotion, cognition, and behavior is a necessary activity at the classroom, school, and, ideally, district levels (Shriver and Weissberg 1996, Weissberg and Greenberg 1997)"* [Elias, p25]

— *"Fourth, building protective factors (e.g., promoting reflective thinking, problem solving, and the ability to accurately anticipate and evaluate situations) that decrease maladjustment is important. Promoting these protective factors also contributes to the amelioration of significant underachievement and promotes skills and the prevention of ado- lescent problem behaviors (e.g., aggression, substance abuse, dangerous risk taking)."* [Zins, p.177]

— *"The second approach is to emphasize skills that are likely to generalize across settings and situations. Self-management skills, for example, involving planning and deliberation, self-monitoring and self-reflection, are applicable to practically all domains of life. Some learning skills, including strategies for acquiring knowledge and learning from feedback, also are likely to generalize."* [Zins, p.81]

Practice. Opportunities for practice are absolutely key for procedural learning. Support for personal experience and hands-on exploration of the skills is thus present across all of the reviewed domains and training approaches. Within the lessons, practice opportunities range from simple model examples that are role-played to trying to utilise situations that occur naturally within the classroom for opportunistic practice. It is however hard for current curricula to go beyond a short-term role-play. This is especially so for topics that are ethically challenging such as responding to conflicts or emotionally loaded situations. And it is even more challenging to design ways to support learners in extending the (controlled) practice opportunities beyond of the immediate teaching interaction.

— *""* [Pasi, p12]

— *"Guideline 8 - Whether applied to recognition, scientific notation, irregular verb conjugation, or SEL, repeated rehearsal using many different instructional modalities provides benefits (Ladd and Mize 1983, Mize and Ladd 1990). There is one main difference between SEL and many academic subjects, however. While SEL entails the learning of many new skills, it may also require the unlearning of habitual patterns of thought and behavior. For instance, students rarely come to class having repeatedly practiced an incorrect version of the multiplication table, but they may have become well schooled in not waiting their turn or not listening carefully to others."* [Elias, p.55]

— can get many others I assume

Embedding and transfer of skills. The ultimate goal of all social and emotional skills training programs is to transfer and embed the skills learned in the classroom context into everyday behaviour and real-world situations. By embedding we mean transforming a skill from one that can be enacted when prompted (e.g., in a practice session) into a skill which becomes an automated, nearly habitual response in everyday settings and situations.

"When individuals feel anxious, angry, or sad, their ability to solve problems or concentrate on learning diminishes (Forgas 1994). Students who have shown improvements in their behavior may revert to earlier, more dominant habits when emotions are strong. When this happens, it is as if the thinking brain in the frontal cortex is overrun by the more automatic responses of the subcortical limbic system (Damasio 1994, Goleman 1995, Sylwester 1995). To avert this occurrence, social and emotional skills must be strengthened through practice in a wide range of contexts. Direct facilitation of classroom instruction may be provided by teachers, school counselors, psychologists, social workers, or paraprofessionals trained in SEL. ... all personnel play an important role in actively encouraging and reinforcing the use of skills and attitudes they see displayed. Throughout the dayon the playground, in the halls, in the lunchroom, on field trips, on the bus, in aftercare programsevery adult has the opportunity to help students in real-life situations use what they have learned in the classroom. Typically, this practice is aided by reminders, usually in the form of tangible prompts. " [Elias, p.56]

Curricula currently approach this, on the one hand, by including real-world examples and situations within the learning context (e.g., asking students to recall and discuss particular experience they had, or having doctors and therapists analyse data from their own practice) and, on the other hand, by attempting to extend the learning context outside of the lessons or therapeutic session. Examples of attempts to extend training beyond the class include: trying to increasing awareness (e.g., posters placed around the building); scheduling follow-up meetings to support recollection of what was learned; and asking the learners' social networks to help reinforce the learning and skills in between sessions. However, the current approaches are limited in scope and effectiveness, and there is little that curricula designers can do to directly influence embedding outside of the learning sessions. As such, this learning principle poses challenges that could perhaps most benefit from technology support.

Motivation and engagement. Supporting motivation and engagement of the learners also plays a major role in all learning experiences and is acknowledged as a key aspect within SEL for education, and increasingly also across all other domains and curricula. Existing work in HCI around creating engaging experiences suggests a potential to augment many aspects of the curricula, making them more engaging and thus motivating for the learners.

In addition to the four learning principles, we also highlight the importance of the *facilitated nature* of most social and emotional learning, pointing to a strong distinction between the directly facilitated learning processes available within the class context and learning outside the class in real-world situations. We will argue later, in section 7.1, how this facilitated learning context opens up particular opportunities for thinking about technology support for SEL – it combines the benefits of a reasonably controlled setting (i.e., teaching curricula with mostly well defined structures; mostly inside a specific room; and facilitated by a SEL expert), but still allows for designing systems for use in real scenarios (i.e., the learning context). This could especially be interesting for initial deployment and exploration of the novel technologies in support of social and emotional learning.

In summary, the four principles point to the key challenges we identified in the existing SEL curricula, and provide a link between the curricula and the potential to support SEL by HCI research. Figure **??** then shows the relationships between the four principles, and puts them into context. Feedback and practice play a central role in learning social and emotional skills, regardless whether within or outside of the learning contexts. Supporting transfer of learned skills by embedding parts of learning into everyday contexts and real-world situations is then one of the key goals in the

training reviewed above. Additionally, learning experiences need to be engaging and motivating to be successful.

5. SUPPORTING SEL WITH TECHNOLOGY - UNCOVERING SYNERGIES WITH HCI

The review of SEL in schools have clearly outlined the fundamental role of experiential learning in development of social and emotional skills. We now highlight embedding as the key aspect through which digital technology may address a crucial need within SEL learning. Moreover, we also highlight promoting reflection and opportunities for practice as two other areas where, based on existing work in HCI, we argue use of digital technology could bring novel opportunities to support and enhance current learning.

[[Rename practice to mixed spaces – a step in between embedding and class-room work]]

— Clear key challenge for the curricula; current approaches do not work well enough.
— We argue digital technology could help in two ways:
  — extending the learning support and scaffolding for learners beyond the lessons, e.g., through mobile and sensor based technology.
  — supporting creation of a wider community around learning of social skills, including involvement of parents, teachers, and peers, e.g., in supporting community building, or methods of remote social support over technology.

[[Can we fit the in class/out of class dimension into here directly? Or at least make obvious that we talk about specific, fixed location and a set of SEL learning that can be supported, and the ability to 'ask' students to volunteer and use particular gatgets (as opposed to random people with a mobile phone at a random location) – should we have a little section on setting affordances upfront?]]

5.1. Learners - Transitioning the skills out of class into everyday situations

When SEL skills are to be learned/transferred beyond the SEL related activities, the learners can no longer take the advantage of the scaffolding existing as part of the SEL exercises. Moreover, to learn from an experience, the student must be notice/observee that a relevant situation has appeared (which is normally inherently present as a part of the exercise setup). In particular,

— *Facilitate identification of teachable moments* learning activities are intertwined with other interactions – it is difficult to identify the teachable moments (although many are available)
— *Scaffolding and structure* – lack of the structure and scaffolding by the teacher present in the session ...
— *Support opportunities to stop-and-learn from experience* – even if students did notice the situation and possibly have might not be supported to step away and reflect on what was happening as other aspects are in play; alternatively, it might be difficult to recall a situation and own reactions reliably, not to mention thinking of better strateries.

We outline each in order below and suggest/envision how technology could enhance these:

[[Can we have an curricula related example or two to start each of the three categories? Could be also something that highlights the (remote) role the teacher could play (e.g., setting up a system to remind students about any discussion they have)]]

5.1.1. Identification of teachable moments

— Possibilities for tracking and suggestions for teachable moments – example re self-control; and the related problem solving.
— For example:

  - strong emotion detection through physiological data ();or audio-recognition algorithms ...
  - also something utilising the social dynamics and observers – e.g., things around turn-taking etc.
  - but also leaving things on the learners – e.g., noticing button.
- Such ambient systems support the user over an extended period of time by sensing, or facilitating tracking of, relevant information and feeding it back in a contextually adequate way, going beyond conscious practice on a one-off basis and under specific circumstances. Systems can also provide on-going subtle cues for facilitating awareness or triggers that remind users to attend to intended activities [Li et al. 2010; Consolvo et al. 2009; Obermair et al. 2008].

5.1.2. Scaffolding and structure to develop skills

- Once aeal-time prompts and reminders to support the scaffolding of activities
- For example:
  - MOSOCO for autism,
  - PopTherapy as a stress relief
  - experience sampling
  - Munson2010 as a positive psychology exercise that structures our interaction with the
  - For example, the MOSOCO project [Escobedo et al. 2012; Tentori and Hayes 2010] exemplifies how mobile phones can help children on the autistic spectrum practise their social skills outside of lessons, and how the system can help elicit feedback from their peers.
- For example, the systems supporting reflection have mostly been developed with real-world use in mind ([McDuff et al. 2012; Balaam et al. 2011a; Stahl et al. 2008; Moraveji et al. 2011]). Initial work has also deployed analogous principles to support emotional awareness training [Matthews and Doherty 2011] and social skills exercises tracking [de Sá et al. 2010] for psychotherapy clients, drawing on the increasing power and ubiquity of mobile phones.
-

5.1.3. Support opportunities to stop-and-learn from experience. [[Will this be a subpart of the scaffolding?]]

- Drawing on tracking and presentation for information for further post-hoc analysis – possibly bringing this back to the classroom.
- suggest a modified SenseCam to promote awareness of changes in*social* states, plans and time (?)
- link to support for reflection in the next section?

5.2. Social support – community building

- parents
- teachers
- peer support - social networking rubbish etc.

5.2.1. Situated social support. Curricula across the domains rely on the trainers or peers to support the learning process by providing feedback, emotional support or tracking progress. However, trainers' or peers' support is problematic to extend and maintain beyond the in-session learning in the current curricula. This is particularly important for SEL in education, where parental involvement (and out-of-session peer pressure) constitutes a major aspect. Prior work in HCI suggests ways of facilitating additional

support and feedback for participants, also from their other social contacts, and outside of the learning sessions.

Initial studies suggest ways by which the expert role of the trainer can be shared with or distributed to other social contacts, such as involving parents or extended family and friends networks. For example, Luckin [2008] developed the Homework system that serves as a link between the school lessons, teachers and parents, facilitating the involvement of the parents in home learning activities of their children; and Hong et al. [2012] explores how a social network can support a person with autism in drawing on advice, help and interactions with an extended network of close others, rather than relying on a single primary care-giver and/or the trainer. Such systems extend the support learners can receive from 'experts' in out-of-session contexts.

Existing work also utilises and supports peer feedback and interaction. Many of the behavioural systems mentioned above work with peer and broader social network cooperation/competition to motivate and engage participants to keep up with their goals, often utilising existing social networks and systems. For example, the Power Agent [Gustafsson et al. 2009] game uses social facilitation, particularly cooperation (with family members and peers) and competition (with other teams) to facilitate learning of energy saving behaviors in a game setting; and the BinCam [Thieme et al. 2012] leverages social influence, in this case mediated via a social network, to foster reflection and behavior change regarding waste and recycling. Similarly, FishSteps [Lin et al. 2006a] takes advantage of social competition to influence people to become more physically active; Gasser et al. [2006] also use social facilitation to support healthy nutrition and activity. Drawing on such peer cooperation or healthy competition could be very beneficial also for many aspects of social and emotional learning.

Finally, social support can be facilitated also by strangers, as is the case with online social networks and support groups. These has been extensively studied and used (see e.g., [Barak et al. 2008; Newman et al. 2011]), especially in the context of patients with chronic diseases (e.g., cancer [Skeels et al. 2010]), and other stressful periods in life (e.g., smoking cessation [Ploderer et al. 2013]). The findings point to the potential of online support groups to provide emotional and information support. Whereas social support groups have been mainly used for distress situations, where users come to discuss their issues and receive information or experiences from others, it would be interesting to explore if a similar model of social support and encouragement is viable for (parts of) social and emotional skills learning.

5.3. Implications of facilitated learning – possible settings

One of the defining features of social skills learning curricula is the combination of facilitated teaching, i.e., learning under the guidance of an expert trainer, and the interplay between learning processes during and outside of the learning sessions. Table 4 flags up our brief discussion on how inside/outside of training sessions differ in terms of affordances, target user groups and types of technology that could be used.

In particular, although one of the key HCI contributions to social emotional learning courses could be extending the learning support *beyond* in-session learning, developing systems for the in-session contexts can be a good first step, both in terms of testing the technology, as well as being directly useful in supporting the facilitator's role and enhancing the learning experience. We suggest that in-session learning is an interesting design space in which novel technologies can be developed – marrying the benefit of direct application into, and testing within, real-world scenarios, with the possibility to do so in a well constrained and manageable environment and with a facilitator who is an expert in both the content and the tools they use.

	In-session learning	Out-of-session learning
Target group	expert trainer learners peers	learners wider social circle (family, friends, colleagues) online networks
Setting affordances	in-doors, often fixed space (used repeatedly) sessions can be structured and controlled interactions can be shaped around technology	everyday settings, changing rapidly, uncontrolled meshing into everyday practice needed e.g., unobtrusive sensing and feedback
Technology	wide range, including VR, biofeedback, video based SSP and similar technologies requiring stable environment can be shared among users, classes	mainly mobile, wearable used by individual users (personalised)

Table 2: Summarising the key differences between in- and out-of-session learning settings

5.3.1. In-session learning. Learning sessions typically take place indoors, involving a mix of lectures and hands-on experiences, likely with an expert trainer/coach present. This leads to a limited, often quite controllable setting for technology deployment and points to particular user roles that can be designed for, such as supporting the trainer's expert role (augmenting and enhancing rather than replacing their skills), facilitating peer feedback or group reflection on examples, and directly supporting the individual learners.

Additionally, the training experiences have a particular quality of being "real" and "not-so-real" at the same time: often asking participants to practise and try new skills out in a "safe place" (e.g., through role play), where potential failures in interaction are actually a valuable basis for reflection and learning, and the expert trainer can immediately assist if problems appear. In this sense, such in-session training is a 'real' situation in terms of the learning setting, but fictional and 'unreal' for the participants, and also a situation that is specifically open to, and designed for, external feedback and reflection.

The combination of the in-class space and the specificity of training experiences potentially allows for a more intricate technology deployment than would be possible in every-day life. Many of the pragmatic and ethical challenges present outside of the classroom are relaxed, such as the possibility to affect, interrupt and shape the interactions; being less difficult to obtain consent with data collection; or the fact that the situation is role-played and thus (most probably) less personally sensitive for participants. Moreover, the 'controlled' training spaces have many additional advantages such as the potential for easier initial technology deployment and lower robustness requirements; or the potential for easy collection of training data corpuses for automated approaches such as social signal processing or affective computing — while still working with the "real" learning process (i.e., not an instrumentally designed laboratory task). The curricula are often well structured, with prepared exercises and model situations known in advance, which can also provide a focus for design work and ease initial deployment of technology.

5.3.2. Out of session learning. Everyday life automatically offers many opportunities to practise social skills. Such practice serves an important role in most curricula as it supports successful transfer of learnt behaviours into learners' lives. The key issue is however that—in contrast to the in-session learning—learners can receive only very little support from the trainer or peers in these settings; thus skills that are not de-

veloped completely are hard to practise successfully. Learners can slip back into their old habits (perhaps not even knowing they are doing so), might not even attempt to try the skills (as the situation is too important), or would need external facilitation to practise successfully.

This points to a number of roles technology is likely to support when facilitating learning outside of the class session. As discussed earlier, systems can focus on individual learners and possible ways in which they can be supported in their practice (e.g., through feedback) and reflection on their behaviours. Alternatively, technology might attempt to seed a supporting environment for the learners through facilitating involvement of their social networks such as family, friends, colleagues into the learning process, supporting peer interaction and support outside of the in-session, or even providing links for the trainer's intervention or support outside of the learning session (and as captured data for feedback in class as will be discussed below).

The "in-the-wild", everyday setting has also implications for technologies used. The mobile and wearable nature of much available technology is likely to be key, together with the need to blend with and into everyday behaviours and still provide meaningful feedback or benefit. Given the interpersonal nature of many social skills, any sensing which might involve people other than the learner outside of in-session learning will need to address many additional complex design and ethical challenges.

Still, supporting and facilitating learning outside of direct learning sessions is the key challenge for social and emotional skills curricula at the moment. We have also seen examples of HCI research in previous sections that have dealt with these successfully (e.g., [Escobedo et al. 2012; Tentori and Hayes 2010; Matthews and Doherty 2011]), suggesting that it is possible to provide beneficial intervention even in such complex settings.

5.3.3. Connecting in-/out-session learning. Another important area for technology support is supporting connections *between* in- and out-session learning. We envision that much has to be possible to extend the current "homework" approach used in the curricula, where the learners are asked to do particular exercises in between sessions and then report back (e.g., in person, and/or via an essay, diary record etc.). Obvious examples of potential for technology support are to: track progress or practice; collect (video/audio) data to support post-hoc reflection or analysis within sessions; and support communication channels to get information/help from the peers or experts even when outside of the session (as discussed above). However, we expect many other, more sophisticated ideas are possible, each drawing on the particularities of the curricula and domain to be supported. An example of such technology, albeit aimed at learning mathematics rather than social skills, is from the Homework project [Luckin 2008], where 5-7 year olds were given tablets and specialised software connecting class work, homework exercises, and facilitating parents' involvement and communication between parents and teachers.

6. DESIGN FACTORS

- **where on the dimension in/out-of-learning we design for – teacher involvement; structuring of activities ...**
- **age appropriate – use the table from Elias to give examples with a reference – e.g., basic behaviours to make friends (SecondStep Kindergarden) vs. leadership skills (RCCP examples for teenagers)**
- **things taught – are there any differences in the four topics we would draw out?**
- **type of feedback?**
- **part of a larger course**

— **at a fixed location – school, thus can expect that infrastructure is possibly deployed around the building**
— design to empower, support exploration

6.0.4. Bringing practice opportunities "into the wild".

One of the key problems existing curricula face when aiming to facilitate practice outside of the lessons is the difficulty in providing learners with sufficient and timely feedback or support during independent practice. This could be in form of real-time feedback during the external practice sessions, but also as a post-hoc support, helping the learner more reliably recall and reflect on their own behaviour.

Many of the feedback options described above have been, or at least have the potential to be, deployed in real-world use, suggesting that such systems could extend practice and feedback possibilities beyond formal learning settings. Prior work also shows how technology can help shape and support practice, in particular interaction strategies outside of the class.

Feedback on other interactional aspects could be deployed in the wild. For example, systems such as Meeting Mediator [Kim et al. 2008b] or those described by Pentland [2008] could easily be adjusted to provide information on real-world meetings. Similarly, existing research suggests that some of the systems based on physiological signals could also be applicable outside of the laboratory or teaching contexts despite the increased noise such situations bring (e.g., [Pan et al. 2011]).

We argue that developing technology to support feedback and practice in the wild would highly benefit existing social and emotional learning programs, regardless of the domain, as it clearly addresses one of the key issues such curricula face. It would, however, also bring crucial challenges to HCI research, requiring systems that are robust enough to cope with "in the wild" settings and to address specific issues around which aspects can be sensed at all, the degree of adaptability, cost-benefit ratio etc. Section 7.2 discusses such technological challenges in more detail.

[[How do we structure stuff – is this going to be drawing out opportunities for tech with a more detailed review later? Or both together?]]

old text:

— Everyday life is full of 'teachable moments' [ref, ref, ref]– e.g., childrens' self-control skills might be tested during playground disagreements or sports events.
— However, these are often hard to learn from directly for students, as the support available is classroom is missing and additional facilitation might be needed for the skills to be practiced properly (e.g., [[add example? such as using teacher to prompt the student to do the Turtle etc?]]), or [[ANOTHER EXAMPLE regarding the post-hoc reflection and learning phase support]] ?
— The first the need to provide **prompts and reminders** about the required activities (cf the use of posters to create awareness [ref]), helping recall and eventually automatise proper behaviours
— The second then leads to post-hoc analysis of own activity, where technology could provide **further data to ground reflection**.

The literature is clear about the challenge curricula face with transfer of learning from classes into everyday behaviour, and the related opportunities to scaffold and support such learning in such everyday situations. This highlights a clear need for the involvement of digital technology. While there has been so far little work in HCI directly on such topics, we argue that prior work around ubiquitous computing etc. suggests technology could successful in supporting this. We outline both the opportunities and challenges for HCI in this space.

Key challenge for HCI: How can technology support learning of social skills in everyday life – How can we sense, track and feedback relevant interaction data?

How can technology structure and scaffold learning our of class – providing a mixed space back to the tutors? Connecting learners? How can technology further support support the actors beyond the the learner themselves? Support (and training) for parents, teachers; building a wider school based community around social and emotional learning.
[[How can we better include autism literature – and where do we show the differences?]]

6.1. Embedding learned skills into everyday life

[[ADD SEL EXAMPLES FOR EACH POINT!]]

Once a skill is partially learned, for example when the learner can enact it in a simulated situation within the class, the ultimate goal of the curricula is to support the learners in embedding such skills into their everyday behaviours and situations. In other words, embedding aims to support the transfer of skills learned in facilitated sessions into skills that are increasingly generalised and ingrained into everyday situations. In this sense, there is a subtle but important difference between embedding (background support for on-going, natural, everyday situations, over longer periods) and practice (a consciously enacted, specific activity aimed at practising a particular skill).

Despite its importance, there is little trainers (or curricula designers) can do to facilitate and support such embedding at the moment. In the rest of this section, we outline two exemplary ways in which existing HCI research might help address the challenge. First, a large body of research exists on using technology to facilitate behavioural change, supporting people in changing their everyday activities and habits. As social and emotional skills are also mostly behaviours (rather than, e.g., declarative 'knowledge'), many of the techniques introduced in HCI to promote behaviour change for health or ecological sustainability are likely to be relevant for SEL. Second, technology can tap into social support for embedding skills in everyday life. For example, technology can be used to share part of the expert/trainer role to other social contacts in the participants' lives, such as drawing on social support and feedback from their friends, colleagues, and parents (in the case of SEL in education); as well as to support interactions with online networks (who may be strangers but who share the same goals). Together, such use of technology has the potential to enhance and augment one of the greatest challenges of the existing social and emotional skills learning curricula.

6.1.1. Behaviour change technologies. Learning new social and emotional skills often includes a considerable change in habits and ways learners would automatically react and/or behave; this is also one of the key reasons why procedural learning is emphasised across all curricula and domains. As already noted, while techniques for procedural learning are well established and available within sessions, curricula currently have few options to support embedding of the skills into everyday patterns of behaviour of the learners.

Behavioural change research within HCI has dealt with similar challenges, mainly in the context of health and ecological sustainability [Hekler et al. 2013; Consolvo et al. 2009; Klasnja et al. 2011; Fitzpatrick and Smith 2009]. Many behavioural change systems are based on pervasive technology used to track user behaviors in everyday life over extended time periods, and to help facilitate users' reflection and discovery of emerging patterns, enable exploration, and monitor own progress. For example, usage patterns of electricity [Gustafsson and Gyllenswärd 2005], water [Kuznetsov and Paulos 2010] and food [Ganglbauer et al. 2013] have been tracked and displayed to users to encourage conserving these resources. Similarly, mobile devices and sensors have been used to continuously track personal information such as physical activity

data [Lin et al. 2006b; Consolvo et al. 2008] to facilitate ongoing awareness and promote healthier lifestyle habits; mobile devices have also been used to help participants manage domestic activities such as TV consumption and household chores [Reitberger et al. 2013], fostering reflection and renegotiation of such activities based on awareness of behaviour patterns over time.

Although behaviour change literature directly addressing social skills is scarce in HCI so far, we expect that similar strategies and technologies we see in other behavioural change topics could work well also for (parts of) SEL. Several examples of existing work provide preliminary evidence on how such long-term support and embedding might be possible. In one such example, Munson et al. [2010] integrated a well-known positive psychology intervention into a social networking site, meshing with users' daily habits around these sites. Similarly, Mamykina et al. [2008] designed MAHI, a system for newly diagnosed diabetes patients, extending the in-class lessons by facilitating participants' ability to track, reflect on and analyse their everyday experiences with diabetes, leading to improved feeling of control over the disease.

Altogether, the examples above suggest that many behavior change techniques have potential to foster the continuous application of learned skills throughout everyday life, and support learners in sustained and habitual use of these skills in the appropriate situations.

6.2. Supporting reflection

Supporting reflection. Second, we saw how the ability to reflect, and become aware of own and others emotions and thoughts underplays all skills taught in SEL; and, more generally, is also understood as the core part of experiential learning. Drawing on the existing HCI work on reflection, albeit currently focused mostly on individuals personal behaviour, we argue that there are great opportunities for digital technology to support also reflective processes underlying the social skills.

Key challenge for HCI: Reflection currently focusses on individual behaviour, initial work supporting emotional tracking, but at the minute mostly everyday pattern tracking (QS). Focus on social aspects is rare, and would pose interesting challenges. How do we develop technology to help children learn reflection processes – designing for surprise, for off-balance moments (draw on Moon)?

Social and emotional skills are hard to track by the learners themselves during the learning process and all curricula incorporate various ways to give feedback on their progress. However, these are mostly based on trainers' or peer feedback, leading to predominantly post-hoc, high-level feedback that is based on recollection. As such, there are explicit challenges and opportunities for facilitation of timely feedback both within and outside of learning sessions.

Prior HCI research suggests that there is a potential for novel kinds of data capture systems that can capture in-situ data such as physiological signals or other sense-able data. In particular, HCI has recently started to focus on tracking aspects that are particularly relevant and important for learning of social and emotional skills, such as emotion detection in affective computing, supporting awareness and personal reflection, and social signals processing. This data can then be re-presented via some form of feedback either in real-time and/or as an explicit resource for post-hoc reflection and feedback, and through many different modalities (e.g., mobile, wearable, haptic, ambient displays; on the group vs. individual level etc.). Such systems could immediately augment and enhance existing curricula and learning processes; in doing so, the SEL context can also raise new challenges for HCI by providing many well-motivated, complex practical problems to tackle for the developing technology.

We outline two areas of HCI systems that are specifically relevant to SEL. First are systems supporting *personal reflection and emotional awareness* (subsection 6.2.1); and second the early work looking into supporting or affecting *communication* (subsection 6.2.2). Due to space concerns, we focus here mainly on work attempting to sense aspects of behaviour that could be used as the basis for feedback. This leaves out other important research exploring the modes in which feedback can be provided. We refer the reader to other reviews, e.g., Börner et al. [2013] discussing feedback via ambient displays in learning contexts.

6.2.1. Reflection and emotional awareness.

Much work has been done recently in HCI around supporting reflection (e.g., [Fleck and Fitzpatrick 2010; Sas and Dix 2011]), recognising and tracking emotions and helping people develop better awareness about, and control over, their behaviours. Such systems would fit well into many aspects across all curricula, such as: the exercises aimed to teach the learners to reflect on, and label, their emotions; emotional awareness exercises in business and medical social skills courses; as well as systems to support personal reflection in psychotherapy and coaching contexts.

Two broader approaches within HCI tap into reflection and emotional awareness. The first is driven by advances in sensor technologies leading to affective computing systems and social signals processing in general (e.g., [Sun et al. 2011; Pentland 2008]), with the aim to automatically assess variables of interest such as conversational engagement or mimicry. Another approach looks at supporting personal reflection by pro-

viding users with additional data about their activities, and aims to support their own reflection, for emotional awareness for example, rather than providing system-based interpretation (e.g., [Kalnikaite et al. 2010; Höök et al. 2008; Slovák et al. 2012]).

Both approaches share the focus on helping users to become more self-aware and draw out patterns that they wouldn't have noticed otherwise by tracking and visualising emotional changes over time. This can be either on a more automatic, affective computing basis, as in AffectAura [McDuff et al. 2012] and Mood Meter [Hernandez et al. 2012]; or with more emphasis on the interpretation on the part of the user such as Affective Diary [Stahl et al. 2008; Sengers et al. 2007; Höök et al. 2008], SenseCam [Kalnikaite et al. 2010; Fleck and Fitzpatrick 2009] or Mood Map [Morris et al. 2010]. Similarly, Subtle Stone [Balaam et al. 2010] presents users with options to indicate their current emotion through an ambient, ambiguous visualisation, very closely resembling the Feeling Faces used in the PATHS curriculum. The nature of the technology could also support more than "just" a moment-to-moment reflection tool, e.g., by enhancing Feeling Faces with tracking and facilitating reflection over time. This would also have the potential to aggregate class 'mood' etc., all of which might be useful additional opportunities for the curricula design.

Other work focuses on supporting self-awareness in-the-moment. Examples are systems such as designed by Moraveji et al. [2011] to support greater awareness of one's own breathing and helping the user to maintain a calm and relaxed state; or mobile tracking systems exemplified by Rabbi et al. [2011]. Such systems might be used either in a nearly unchanged form as a part of supporting mindfulness and breath control techniques, which are taught across a number of domains; they can also serve as inspiration for new systems aiming to reflect background awareness of other aspects trackable by technology. To summarise, these examples illustrate systems that can support users in reflecting on their emotions and behaviour, but do not necessarily aim to help control or react to emotions or behaviours when these are recognised.

Self-control is another key component of many of the curricula across domains. A specific focus is often given to impulse management, such as in response to anger or acute stress, where the pivotal aspect is realising that one is getting angry or stressed, and then triggering the appropriate response, e.g., techniques for calming down. However, it is challenging to get feedback promptly when learning to do this. Recent advances within affective computing that draw on physiological signals could be particularly useful here. For example, Bouchard et al. [2012] shows how a short training based on a combination of physiological signals feedback and a computer game as a stimulus can help soldiers better manage their stress in real-world situations, reporting significantly better results than traditional techniques. Similarly, there are recent results suggesting a range of other possibilities, e.g.: to automatically track seizures [Poh et al. 2012]; to detect arousal increase in people on the autistic spectrum [Picard 2009]; and to detect interruptions [Pan et al. 2011]. All of these have been applied outside of the lab and in (close to) real-world settings. Additionally, much social signals processing work shows promise for providing additional approaches to detecting key inter-personal emotional states such as anger or stress with sufficient precision, building on audio and video analyses techniques [Vinciarelli and Pantic 2012]; these are techniques that might well be suited for tracking within the classroom/training room (or other enclosed spaces such as a meeting room).

Such systems would fit well with the content of many of the curricula across the domains, where the students are taught to observe and reflect on the changes felt in their bodies during (and at the beginning) of such episodes. Moreover, many of the sensors are wearable and are likely to become unobtrusive soon, suggesting the potential to support feedback outside of the classroom and during everyday life. Other aspects of managing one's own emotions focus on keeping up motivation, postponing pleasur-

able experiences etc., and could perhaps also be facilitated by providing support for relevant personal reflection; or might even have measurable correlates detectable by sensors or analysis of logged data.

6.2.2. Communication skills.

Many curricula involve exercises to teach particular communication skills and interaction strategies. Prior work in HCI suggests ways in which technology might support and enhance the feedback possibilities, with the potential to make communication learning more effective. In particular, a number of papers show how relevant aspects of interaction are trackable in real-time, and how providing feedback on these can affect and change interaction in positive ways. These systems suggest that similar feedback could be useful for many aspects of the curricula, including active listening, constructive communication styles or perspective taking exercises.

For example, the Meeting Mediator system by Kim et al. [2008b] directly feeds back speaking behaviour of participants in a discussion. Such feedback lowers domination of individuals and helps achieve a more balanced discussion. Similarly, Pentland [2008] shows techniques to track aspects such as influence or activity within the interaction and Gatica-Perez [2009] reviews other methods to analyse and track aspects of social interaction in small groups. Moreover, DiMicco et al. [2007] discusses how increased awareness of parts of the interaction can affect and shape group dynamics. There are also indications that even subtler elements of interpersonal interaction can be addressed. For example, Balaam et al. [2011a] shows how feedback based on non-verbal behaviour can affect and increase feelings of rapport. Although Balaam et al. [2011a] used Wizard of Oz techniques to select the indicators, there are already several systems that aim to automate similar tracking [Sun et al. 2011; Hagad and Legaspi 2011]. Similarly, Daily [2010] uses physiological data to provide a posteriori feedback on group discussion in classes, supporting improved reflection of the shared experience and empathy. Skinner et al. [2009] present a technology based course for medical doctors based on a lecture and a set of video clips demonstrating important aspects, tailored to each doctor by including relevant fragments of the doctor's own interactions with patients recorded earlier. A randomised control trial shows a significant improvement in doctors' empathy towards patients in contrast to a wait-listed control group [Tulsky et al. 2011].

In summary, many of the systems outlined above show the potential of technology to capture relevant data that can be used to provide novel feedback mechanisms in relation to self-awareness and social communication skills, and could easily help with many of the challenges curricula designers face.

6.3. Practice

Facilitating practice of skills. Practice is the second fundamental aspect of experiential learning, and is heavily utilised in the curricula , e.g., in the form of simulation of sel related situations. We again highlight how use of technology, e.g., in the form of novel environment for practice (games, augmented reality, VR...), could provide the learners and curricula designers with a novel opportunities to enhance and improve the training.

Key challenge for HCI: While existing games/environments ....

All the reviewed curricula aim to provide extensive opportunities for practice, mainly within the lessons, using role-plays and model situations as the key methods. The goal is to practise 'proper' reactions and understanding of situations and challenges one can face in daily life. Participants are also encouraged to continue practising the new skill outside of the class setting. By practice we mean here a consciously accomplished activity with the goal to further develop the skill in question.

Existing HCI literature points to two areas which are directly relevant. The first is receiving feedback on one's own behaviour, which is key for successful practice. The types of systems outlined in the previous section can directly extend the opportunities for students' practice, especially outside of learning sessions where little or no feedback is otherwise available. Thus facilitating practice 'in the wild' presents novel opportunities and challenges for many applications of ubiquitous computing, such as wearable, mobile and sensor-based technologies. Second, recent work on conversational/relational agents together with research on virtual spaces points to novel, easily controllable and configurable environments that could allow students to practise in a wide range of novel model situations, settings and on a range of topics. This would be especially useful for concepts that are problematic to tap into normally, either due to ethical concerns (e.g., dealing with a conflict situation) or that are not feasible to enact in class. We review the two areas below.

6.3.1. Novel environments for practice. Curricula across all domains include a large number of role-play or modelling examples, allowing the learners to test and explore skills in a safe situation. Prior research suggests that technology could support novel settings by providing virtual environments or games that can substantially extend and augment the opportunities for such role-play and practice.

Initial work on 'serious' games suggests that these can address many complex concepts relevant to social and emotional learning, and do so in an engaging way. For example, Coyle et al. [2011] shows how a specially designed game can enhance and positively augment cognitive behavioural psychotherapy, especially for teenage patients. Similarly, prior research has looked at the possibilities of novel interfaces such as multi-touch tabletops to augment therapy with autistic children, including aspects of cooperation [Piper et al. 2006] or communication skills [Zarin and Fallman 2011]. Moreover, there is initial evidence that similar serious games could help people from non-clinical populations. For example, Hailpern et al. [2011] designed a game that helps relatives and friends of patients with aphasia to increase awareness and understanding of the aphasia disorder, and how it must feel for the patients themselves; and Rusch [2012] aimed to facilitate a similar understanding of depression. Similarly, Rubin-Vaughan et al. [2011] developed and deployed a curriculum consisting of a series of games that help children practise their social skills, such as perspective taking, with a specific focus on bullying prevention exercises. Altogether, this works suggests that serious games have the potential to augment the learning of complex social and emotional skills, including topics such as perspective taking, empathy, active listening, and exploring the impacts of one's choices.

Augmented and virtual reality (AR and VR) environments have been successfully used in similar contexts. For example, virtual reality is increasingly applied in therapy to help people control social phobias (e.g., [Romano 2005]), reduce physical pain [Gromala et al. 2011], or reduce posttraumatic stress disorder and support resilience [Rizzo et al. 2013]. Further, an increasing number of papers draw on Bailenson et al. [2008] and explore how changing aspects of interaction in virtual reality affects learning or behavioural change. For example, Fox and Bailenson [2009] suggests that amplifying feedback of user's actions (e.g., the character gets literally slimmer when exercising) can increase the persuasive impacts that transfer to the real-world (e.g., more exercise in the voluntary phase of the study); or that experiencing a "superpower" within virtual reality can lead to measurable increases in prosocial behaviour in the real-world [Rosenberg et al. 2013]. Augmented reality environments have also been used in other educational settings, although mainly for cognitive rather than social or emotional skills learning, see Wu et al. [2012] for a review. Additionally, research on embodied agents presents initial work on using agents to support learning of particular skills,

such as negotiation in Core et al. [2006], or preparing for a job interview [Hoque et al. 2013]. Much work also focusses on creating virtual agents that can elicit feelings of empathy, support and maintain relationships [Bickmore and Picard 2005; Bickmore et al. 2010], often building on concepts such as mimicry or rapport. In summary, social and emotional learning curricula could especially benefit from VR or augmented reality systems given the potential to simulate situation that be difficult or impossible to stage in real-life; and perhaps even more so in combination with the gaming and embodied agents elements described above (as VR seems to intensify the immersion).

6.4. Engagement and motivation

Facilitating engagement and supporting motivation of the learners is important across all domains and curricula. A large body of work in HCI focuses on creating engaging experiences, showing the potential of technology and design to enhance users' engagement with a wide range of aspects, activities and concepts such as school education [Connolly et al. 2012; Bers 2010], digital art [Edmonds 2013], or stroke rehabilitation [Balaam et al. 2011b] to name just a few. This breadth of topics, as further illustrated, e.g., in the Funology book [Blythe et al. 2004] and subsequent research, suggests the high potential of similar approaches to augment many aspects across the curricula, making social and emotional skills learning more engaging and motivating.

Similarly, the recent uptake of systems that aim to support users' engagement through 'gamification' or 'gameful design' [Deterding et al. 2011; McGonigal 2011] could be particularly relevant to social and emotional skills curricula, integrating game mechanics like rewards, goals, points or challenges into real life activities. For example, Superbetter[9] aims to help players increase their personal resilience, using a structure of quests, adversaries, and power-ups to engage players with scientifically endorsed exercises. Other applications in this area are related to behaviour change technologies, such as supporting users to become more fit (e.g. via activity tracking sensors coupled with gamified services such as Nike+ and Fitbit), lose weight (Withings) or to improve people's sleep (Zeo). Gamification approaches have been also successfully applied in education (e.g., [Torres and Wolozin 2011; Sheldon 2011; Mamykina et al. 2008]), as well as psychotherapy work [Goh et al. 2008; Piper et al. 2006]. Several game-based systems looking at social skills with children also report positive effects and high engagement of the users, e.g., [Hourcade et al. 2013; Hendrix et al. 2009].

All of these examples highlight the possibility of technology based systems to create intrinsically motivating applications that draw user in and are fun to interact with, regardless of the activity or behaviour to be supported.

6.5. Summarising technology roles across learning principles

Across all of these examples, we see a range of successfully deployed—or potentially deployable—HCI systems. While the presentation was so far structured according to the learning principles (showing HCI can address the key challenges), we can also see across the presented examples broad categories of types of technologies that can be deployed to support different principles. We draw out some of these categories here to illustrate the general classes of technologies that can support SEL. This variety also points to the complexity of the design space and emphasises that supporting a particular learning principle does not necessarily prescribe a particular role for, or type of, technology.

(1) **Expert sensing:** Some of the systems rely on sensing and automated interpretation of behaviour, helping users draw out patterns they were not aware of before.

[9] http://www.superbetter.com/

Information can be presented in real-time, such as giving feedback on communication behaviour in meetings [Kim et al. 2008b; DiMicco et al. 2007], or over longer periods of time such as in AffectAura [McDuff et al. 2012]. Such systems often draw on and connect many disparate data sources.

(2) **Structuring activities:** Other systems aim to provide timely reminders to support users behaviour. They may provide data for the user to reflect and act on, but rely much less on automatic sensing and interpretative capabilities of technology, leaving the interpretation to the user. Examples can be found in autism technology such as MOSOCO system [Escobedo et al. 2012] listing the appropriate actions the person should take and asking them to rate their performance (i.e., no sensing on the part of the system); personal reflection tools, such as Affect Diary [Stahl et al. 2008] and systems around SenseCam (e.g., [Fleck and Fitzpatrick 2009]; or facilitating keeping of diaries in psychotherapy [Matthews and Doherty 2011].

(3) **Novel experiences:** A third role we saw systems take was to facilitate or create novel experiences. This can be either by providing a 'new world' to behave in, as per (serious) games [Hailpern et al. 2011] and virtual reality [Bouchard et al. 2012; Romano 2005]; or by helping the users to get a novel perception of a particular behaviour such as through gamification of real-world experience (e.g., Superbetter app) and the accentuated feedback in systems developed by Bailenson et al. [2008].

(4) **Connecting and sharing:** Fourth role was in supporting connecting and sharing among larger groups of users. For example, facilitating cooperation by reaching out to social support nets (e.g., [Newman et al. 2011]), or the family/friends circle (e.g., [Hong et al. 2012; Munson et al. 2010]).

Selected areas	Specific topics
Implications of the facilitated nature of SEL	• in-session vs. out-of-session learning and the specific opportunities and challenges of each • ways to facilitate connections between in-/out-of-session learning
Technology challenges	• sensing of the interpersonal aspects – 'in the wild', robust technology • supporting the complexity of curricula – adaptability, modularity • dealing with privacy, ethics, up-keep costs and servicing of technology etc.
Design challenges	• ways to support cooperation with curricula designers • designing to *`teach and disappear'* • challenges shared with other ubicomp systems
Methodological challenges	• accommodating the complex structure and long-term methods of curricula design • matching evaluation approaches with those used in HCI research • finding a good balance of roles for HCI involvement

Table 3: Mapping out the design space of SEL – summarising the areas bringing key challenges and opportunities for HCI research

7. MAPPING OUT THE DESIGN SPACE – OPPORTUNITIES AND CHALLENGES FOR HCI

Previous sections have so far looked at what social skills curricula focus on and where the challenges lie (sec 2-4); and then provided examples showing how these challenges and learning principles could be supported by technology (sec 5). While drawing out some of the HCI research that is already very relevant to these domains, section 5 was however still structured by the learning principles and social skills learning challenges, aiming to show that HCI has the potential to address many of the key issues there.

In this section we take a different viewpoint and outline the challenges (and thus also opportunities) that supporting social and emotional skills curricula would pose to HCI, across the learning principles and curricular domains. We focus on four main areas, outlined below and in Table 3:

— We first discuss the **implications of the facilitated nature** of the social skills learning curricula, leading to distinguishing inside and outside of the training session as two core settings for design of systems in this area. We outline how they differ in their affordances, possible target groups of users to design for, and the differences in what types technology could be most useful in each; also highlighting the need for technology that would help connect together the learning processes inside/outside.
— Second, we discuss the **challenges for technology** posed by the social skills learning space. We start with the two key technical challenges in this space: sensing interpersonal signals relevant to social skills teaching, and the need for adaptability and modularity of technology due to the complexity of the curricula to be supported. We then briefly discuss many other challenges that are shared with other ubiquitous applications (e.g., privacy, ethics, timely feedback, maintenance of deployed technology).
— Third, we look at some of the **design challenges** this space poses. Apart from the common issues again shared by other ubiquitous applications, we draw out two more

	In-session learning	Out-of-session learning
Target group	expert trainer learners peers	learners wider social circle (family, friends, colleagues) online networks
Setting affordances	in-doors, often fixed space (used repeatedly) sessions can be structured and controlled interactions can be shaped around technology	everyday settings, changing rapidly, uncontrolled meshing into everyday practice needed e.g., unobtrusive sensing and feedback
Technology	wide range, including VR, biofeedback, video based SSP and similar technologies requiring stable environment can be shared among users, classes	mainly mobile, wearable used by individual users (personalised)

Table 4: Summarising the key differences between in- and out-of-session learning settings

specific aspects: On one hand, the focus on designing technology that facilitates or 'scaffolds' learning of skills, but is expected to be removed once the skills are learned. On the other, there is a potential for a large scale, real-world impact of technology that would get incorporated into curricula. However, this comes together with the design challenges connected to the complex, multi-disciplinary interventions to be supported, which involve many stakeholders and policy decisions as well as strict requirements on cost-effectivity and robustness of developed technology.

— Fourth, we briefly outline some of the **methodological challenges** brought by co-operation with large scale interventions and related research. These draw on differences in the structure and time span of research on educational curricula, and the approaches common in HCI. Similarly, the evaluation of the developed technologies might require novel methodology approaches, perhaps drawing on and re-appropriating the knowledge already existing educational and related domains. We conclude with a short discussion about what could be the role and contribution of HCI in this space.

7.1. Implications of facilitated learning – possible settings

One of the defining features of social skills learning curricula is the combination of facilitated teaching, i.e., learning under the guidance of an expert trainer, and the interplay between learning processes during and outside of the learning sessions. Table 4 flags up our brief discussion on how inside/outside of training sessions differ in terms of affordances, target user groups and types of technology that could be used.

In particular, although one of the key HCI contributions to social emotional learning courses could be extending the learning support *beyond* in-session learning, developing systems for the in-session contexts can be a good first step, both in terms of testing the technology, as well as being directly useful in supporting the facilitator's role and enhancing the learning experience. We suggest that in-session learning is an interesting design space in which novel technologies can be developed – marrying the benefit of direct application into, and testing within, real-world scenarios, with the possibility to do so in a well constrained and manageable environment and with a facilitator who is an expert in both the content and the tools they use.

7.1.1. In-session learning. Learning sessions typically take place indoors, involving a mix of lectures and hands-on experiences, likely with an expert trainer/coach present. This leads to a limited, often quite controllable setting for technology deployment and

points to particular user roles that can be designed for, such as supporting the trainer's expert role (augmenting and enhancing rather than replacing their skills), facilitating peer feedback or group reflection on examples, and directly supporting the individual learners.

Additionally, the training experiences have a particular quality of being "real" and "not-so-real" at the same time: often asking participants to practise and try new skills out in a "safe place" (e.g., through role play), where potential failures in interaction are actually a valuable basis for reflection and learning, and the expert trainer can immediately assist if problems appear. In this sense, such in-session training is a 'real' situation in terms of the learning setting, but fictional and 'unreal' for the participants, and also a situation that is specifically open to, and designed for, external feedback and reflection.

The combination of the in-class space and the specificity of training experiences potentially allows for a more intricate technology deployment than would be possible in every-day life. Many of the pragmatic and ethical challenges present outside of the classroom are relaxed, such as the possibility to affect, interrupt and shape the interactions; being less difficult to obtain consent with data collection; or the fact that the situation is role-played and thus (most probably) less personally sensitive for participants. Moreover, the 'controlled' training spaces have many additional advantages such as the potential for easier initial technology deployment and lower robustness requirements; or the potential for easy collection of training data corpuses for automated approaches such as social signal processing or affective computing — while still working with the "real" learning process (i.e., not an instrumentally designed laboratory task). The curricula are often well structured, with prepared exercises and model situations known in advance, which can also provide a focus for design work and ease initial deployment of technology.

7.1.2. Out of session learning. Everyday life automatically offers many opportunities to practise social skills. Such practice serves an important role in most curricula as it supports successful transfer of learnt behaviours into learners' lives. The key issue is however that—in contrast to the in-session learning—learners can receive only very little support from the trainer or peers in these settings; thus skills that are not developed completely are hard to practise successfully. Learners can slip back into their old habits (perhaps not even knowing they are doing so), might not even attempt to try the skills (as the situation is too important), or would need external facilitation to practise successfully.

This points to a number of roles technology is likely to support when facilitating learning outside of the class session. As discussed earlier, systems can focus on individual learners and possible ways in which they can be supported in their practice (e.g., through feedback) and reflection on their behaviours. Alternatively, technology might attempt to seed a supporting environment for the learners through facilitating involvement of their social networks such as family, friends, colleagues into the learning process, supporting peer interaction and support outside of the in-session, or even providing links for the trainer's intervention or support outside of the learning session (and as captured data for feedback in class as will be discussed below).

The "in-the-wild", everyday setting has also implications for technologies used. The mobile and wearable nature of much available technology is likely to be key, together with the need to blend with and into everyday behaviours and still provide meaningful feedback or benefit. Given the interpersonal nature of many social skills, any sensing which might involve people other than the learner outside of in-session learning will need to address many additional complex design and ethical challenges.

Still, supporting and facilitating learning outside of direct learning sessions is the key challenge for social and emotional skills curricula at the moment. We have also seen examples of HCI research in previous sections that have dealt with these successfully (e.g., [Escobedo et al. 2012; Tentori and Hayes 2010; Matthews and Doherty 2011]), suggesting that it is possible to provide beneficial intervention even in such complex settings.

7.1.3. Connecting in-/out-session learning. Another important area for technology support is supporting connections *between* in- and out-session learning. We envision that much has to be possible to extend the current "homework" approach used in the curricula, where the learners are asked to do particular exercises in between sessions and then report back (e.g., in person, and/or via an essay, diary record etc.). Obvious examples of potential for technology support are to: track progress or practice; collect (video/audio) data to support post-hoc reflection or analysis within sessions; and support communication channels to get information/help from the peers or experts even when outside of the session (as discussed above). However, we expect many other, more sophisticated ideas are possible, each drawing on the particularities of the curricula and domain to be supported. An example of such technology, albeit aimed at learning mathematics rather than social skills, is from the Homework project [Luckin 2008], where 5-7 year olds were given tablets and specialised software connecting class work, homework exercises, and facilitating parents' involvement and communication between parents and teachers.

7.2. Technology challenges

There are also challenges that technology deployment will face in the area of social and emotional learning. While many of these are shared with other ubiquitous applications, some are more specific to SEL. First is the sensing and processing of aspects relevant to feedback on social skills that are mostly based on interpersonal interaction and complex concepts. Second is related to the complexity of many curricula and the need to make technology support particularly adaptable, modular and re-usable.

7.2.1. Sensing of interpersonal aspects. Automatic capture and processing of data that is robust and reliable is often difficult in the wild, especially if it is to be meshed fluidly with other complex interactions (as will be the case in both in-session and out of session systems here). However, sensing and processing of aspects relevant to social skills is likely to be challenging by itself, even in controlled laboratory conditions.

This is partly due to the interpersonal nature of the sensed data, which has not been common in social signals processing, affective computing or related fields that focus so far mostly on individuals [Vinciarelli and Pantic 2012]. Additionally, many of the social concepts taught in the courses are holistic and are yet to be defined in a way that would allow automatic sensing; it might even be impossible for some. Support for social and emotional skills courses thus raises many well-motivated research questions around which aspects can be sensed and interpreted[10], and whether that is possible on the individual or interpersonal level (i.e., combining sensed data across participants).

There is also a question of the level of interpretation we expect the system to provide. This leads to a continuum from leaving the sense-making of raw data entirely to the user and/or the facilitator (e.g., as per SenseCam systems [Fleck and Fitzpatrick

[10]An intriguing parallel can be seen in psychology of interpersonal judgments, where a large body of research shows that human raters can reliably judge complex concepts such as perceived warmth or friendliness of a conversation on the macro level (gut instinct), but even after many studies micro-coding many of the non-verbal signals (head nods, movements etc.), it is still unclear what cues raters draw upon to make their intuitive judgements [Ambady et al. 2000] or [Harrigan et al. 2008, p.299].

2009]), to providing full interpretation by the system (e.g., as in arousal detection for people with autism [Picard 2009]). Even if particular concepts cannot be reliably and fully interpreted by technology, it might still be possible, and in many cases actually preferable, to support the users by providing a 'reasonably' pre-processed data they can view, interpret and reflect on.

7.2.2. Complexity of curricula – need for adaptability and modularity. Another challenge is posed by the complexity of curricula, the wide range of skills that are usually taught and the developmental/progressive nature of skill acquisition. This suggests the need for modularity of the designed systems and preference for highly versatile and reusable designs that can be adapted for teaching many aspects within the curricula and personalised to individual learning paths. Cost-benefit ratio and robustness of the system will be also important, both in terms of durability and reliable sensing in difficult real-world environments, regardless of context and setting. These will be especially crucial if the aim is to deploy technology as a part of existing curricula. Technology will also need to adapt to the differences among domains and settings, and the related variances in the length, focus and breadth of curricula, even when supporting a concept important across the domains (such as self-reflection). For example, we expect differences between designing for young learners (such as in education curricula and psychotherapy for adolescents) and for adult learners (e.g., in business and medical domain courses); and differences in supporting social skill acquisition for professional versus personal motivations.

7.2.3. Challenges shared with other ubiquitous systems. Many of the challenges in this design space are shared with other ubiquitous computing applications. For example providing timely, unobtrusive feedback is often a challenge for ubiquitous applications, even if the sensing and processing issues described above are resolved; as are issues around managing and keeping the technology running once deployed. Privacy needs to be addressed whenever a system includes sensing or data collection, especially so if the goal is to sense interpersonal aspects of an interaction. Finally, ethical concerns regularly arise, particularly when working in sensitive settings such as education of young learners or in the medical domain. For a more detailed discussion of such issues in other contexts see e.g., Caceres and Friday [2012], Consolvo et al. [2007] and Kientz et al. [2007].

7.3. Design challenges

There are also many design challenges shared with other ubiquitous systems, but some are quite specific to SEL. We discuss two such key aspects. First is a combination of an opportunity and a challenge: the potential for large scale, real-world impacts *if* the technology is accepted by the curricula design community. This however brings the need to closely cooperate with curricula designers and address serious challenges due to the particularities of the setting, the interdisciplinarity of such projects, the interactions with policy makers etc. Second is designing technology as a temporary scaffold not as a permanent crutch, i.e., designing with the aim to help teach new skills over a limited period of time, after which the technology is expected to be taken away or no longer needed, and where the skills persist. Finally, we then highlight the more common ubiquitous technology design decisions, drawing out those that might be particularly relevant to the SEL area.

7.3.1. Need for cooperation and knowledge sharing with curricula designers. The learning principles identified earlier—together with curricula descriptions available in literature—are likely to help initial explorations of the design space. However, developing systems either in collaboration with curricula designers, or directly for specific

existing curricula will be crucial for real-world usefulness and deployment of the developed systems. Coyle et al. [2007] have discussed this issue with respect to designing for the mental-health domain; Porayska-Pomsta et al. [2011] address the challenges of similar interdisciplinarity in designing for autism. We will argue in the next section how their approach can be extended to the whole setting of social and emotional skills, and return to the methodological challenges brought about by such interdisciplinary cooperation.

7.3.2. Designing to "teach and disappear". Most social and emotional skills courses, irrespective of domain, run only for a limited time. This can often be as short as a few hours or a weekend; or span longer time periods, but possibly limited to several hours every week (e.g., as in K9 school curricula). In both cases, the aim is to facilitate development of new skills over the duration of the course, and it is crucial that the skills become embedded enough to persist even after the course is finished. Although it might be relevant for some cases to develop technology that allows to extend or supplement the course duration, the ultimate goal of technology is likely to scaffold and help learn skills that will stay available *after* the technology is taken away. This provides interesting and novel challenges to designing systems, especially with the potential to enriching approaches used in behavioural change and related fields. Additionally, such a focus calls for designs that can adapt and follow the learning curve of students, always supporting the next 'zone of proximal development' [Vygotsky 1987].

7.3.3. Design challenges shared with other ubiquitous systems. Designing for social and emotional skills is also likely to raise many issues that have been already widely discussed in earlier work around ubiquitous systems and related technology. These can be challenges around privacy and the degree of control given to users; need for adaptability and personalisability, as well as designing with sensitivity to different cultures. Other factors will likely involve decisions around making the technology individualised or shared by many; the feedback style (give "expert" opinions, or leave interpretation open to users) or feedback mode (ambient vs. explicit feedback), as well as the need to include many potentially competing requirements (e.g., the need to address most if not all learning principles). Pragmatics will also come into play including issues around designing for difficult settings (e.g., schools with high violence and poverty rates); or supporting training and ease of use of technology for trainers and learners, especially in large-scale deployments. See, e.g., Consolvo et al. [2007] or Rogers et al. [2007] for an in depth discussion of similar issues.

7.4. Methodological challenges

Research on social and emotional skills will likely also bring novel methodological challenges, especially if the aim is inclusion or co-design of the technology in large-scale curricula projects, and its acceptance by curricula designers and policy makers. Here we focus mainly on such co-operative projects, as these are likely to have the highest potential for large-scale impact of HCI research; but also present specific challenges. We discuss three interrelated issues: structure and methods usually imposed on research in curricula design projects; the approaches to evaluation in these domains; and the possible roles HCI could take in this space.

7.4.1. Structure and methods. Curricula tend to be very complex, large scale interventions, especially so in the education and the medical settings. Designing technology for these settings will need to take into account the longer term time-span and intense focus of research projects in these domains, where it is usual to take many years to develop and test a curriculum. For example, Matthews and Doherty [2011] show how

such co-operation is possible and discuss the development, deployment and clinical trial of a mobile-phone support for psychotherapy with adolescents.

Although it is potentially challenging to accommodate this in the quicker turnaround of projects usual in the HCI space, such sustained focus and long-term research agendas may have a beneficial impact on research on social skills and interaction within HCI more generally. Whereas existing HCI work on teaching social and emotional skills has been mostly fragmented (except perhaps for autism research), often in the form of single studies, with little long-term follow-up, the structure inherent in SEL curricula might promote more systematic research and lead to highly successful, real-world applications. Such projects could enrich HCI approaches with methodologies, contexts and goals that are well defined, well researched and very well motivated by real-world needs.

7.4.2. Evaluation approaches. Approaches to evaluation methodologies also tend to differ between curricula designers and most of HCI work. There is a push for an "evidence based" support for curricula interventions, as required by the policy makers. This leads to a sequence of increasingly complex studies, starting from formative, small pilot studies that test viability of particular ideas; through larger, longer term studies to confirm potential; and eventually building up to multi-site trials, often in the form of randomised control trials or similarly resource intensive methodologies such as complex quasi-experimental designs, which are less common in HCI. So although there is a mix of qualitative and quantitative methods inherent in the design and initial exploration of curricula, there is a call for mostly quantitative methods to test the effects of a developed curriculum on outcomes in the long term. There is also the potential for HCI to influence these evaluations with a complementary focus on the processes and interactions through which such outcomes are achieved. This can impact the roles HCI might take in this domain, as discussed in the next section.

7.4.3. Roles for HCI. The complexity, scale and dependencies of such large-scale projects necessarily affect ways in which we as HCI practitioners can engage. An extensive discussion of similar issues in related domains is already available. For example, Coyle et al. [2007] suggests a two stage process in the area of talk-based therapies, where the first exploratory part is led by HCI with cooperation from experts from the other domain, aiming to iteratively develop and run initial evaluations of promising systems to the point "where they are shown to be usable by the target end users, are agreed to have clinical validity and are predicted to have therapeutic benefits." Stage two then focuses on larger scale evaluations and the roles exchange: the lead is assumed by the curricula experts with HCI researchers in a collaborating role, and receiving feedback on the systems use in real-world practice. Fitzpatrick and Ellingsen [2012] discuss similar issues in their review of CSCW systems in medical settings, arguing for the need to engage with and raise awareness of CSCW (and HCI related) issues with many of the stakeholders.

We suggest a combination of the Coyle et al. [2007] model of cooperation with curricula designers, complemented with another stream of more independent, smaller, exploratory studies that try to push the boundaries of what might be possible to do with technology in the first place. In other words, we can see benefit in parallel research on two areas: (i) aiming for large scale, real-world impact with technologies/ideas that are already matured in HCI, in close cooperation with curricula designers and large interdisciplinary projects; and (ii) more exploratory HCI process, that draws on existing curricula and the challenges, bringing novel, untested technology and exploring a broad range of viable approaches that eventually feed into the first stream. It is our hope that this article could inspire future work pursuing either of the two direction.

8. CONCLUSIONS

This paper points to the potential synergy between HCI and social and emotional skills learning, benefiting both disciplines. We outline the key challenges for current SEL approaches, show how these could be supported by technology, and highlight the new challenges and opportunities this would pose to HCI. In doing so we have presented a set of structured concepts and characterisations of SEL to help frame an agenda for further research. We provide a summary of the topics, methods, and learning principles, and their associated challenges in SEL across the domains (Table 1); we review HCI research relevant to the respective challenges (Table **??**) and outline the design space and opportunities for HCI (Table 3).

In particular, the curricula across all domains struggle with providing *timely feedback* (currently post-hoc, coming from trainer/peers); creating opportunities for *real-world practice* (currently limited mostly to in-session training); *embedding learnt skills into everyday life* (very little is possible for curricula designers at the moment); and *facilitating engagement and motivation*. The overarching challenge across these issues is the need to extend support for out-of-session learning, which is fundamental for social and emotional skills but hard to facilitate for the current curricula. The review of existing HCI research shows there are strong indications that technology can help address many of these challenges; particularly as many HCI approaches that were not connected to social and emotional learning so far could directly contribute here.

HCI involvement in this space has the potential for strong, real-world impacts. Social and emotional skills learning is crucial for diverse domains and ages, such as education (from kindergarten to high-school), business, medical, therapeutic and everyday settings. Good SEL programmes are therefore relevant for an increasingly wide range of potential learners, and not limited to special-needs groups such as autism or psychotherapy patients. Moreover, engaging with these contexts is likely to bring well-motivated problems to tackle for many developing technologies (e.g., 'in the wild' social skills processing), raising novel challenges for future HCI research.

We end by highlighting three selected aspects of SEL we personally find particularly interesting for immediate future work within HCI. These are (i) addressing the support for social and emotional learning in education of neuro-typical children (a domain with a long history, many curricula that are widely applied, but so far under-researched in HCI); (ii) the implications of supporting facilitated learning in SEL (and the differences in design settings it brings); and (iii) finding ways to mesh HCI research and technology support well with the curricula design (building on the long history of research there).

Overall, this paper suggests that social and emotional learning points to a complex, intriguing research space, which has a high potential to enrich HCI research and practice. It is our hope that while the characterisations and distinctions suggested in this paper could be useful for immediate future work into this space, further research will elaborate on, clarify and extend, rather than reify, these.

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Authors' statement

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