Magis – A magical adventure: Using a mobile game to deliver an ACT intervention for elementary schoolchildren in classroom settings

K. Keinonen [a,*], P. Lappalainen [a], S. Kotamäki-Viinikka [b], R. Lappalainen [a]

[a] University of Jyväskylä, Jyväskylä, Finland
[b] University of Vaasa, Vaasa, Finland

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ABSTRACT

Studies of the effects of the COVID-19 pandemic have shown that this health emergency has affected especially young people. Supporting the well-being of children is thus particularly urgent. However, the high prevalence of ill-being among children requires novel approaches to providing help. Health care resources are limited, and many children did not receive support even before the pandemic. The current study presents a novel approach to delivering brief interventions for school-aged children. A mobile game based on acceptance and commitment therapy was used to increase psychological flexibility and well-being among 10 to 12-year-old schoolchildren. A sample of 106 students played the game in four weekly sessions as part of normal teaching practice in school. The effectiveness of the brief game intervention was examined as a universal intervention among the whole sample and among subgroups created on the basis of baseline psychological flexibility (i.e., based on the need for an intervention). The results show that higher psychological flexibility was associated with less emotional and behavioral problems, higher health-related quality of life, mood, and school satisfaction, and less loneliness ($r = 0.46$–0.63). While a significant effect was not detected in the whole sample, the subsample of children with initially high psychological inflexibility benefitted from participating in the intervention (Cohen's $d = 0.35$). These preliminary findings suggest that the brief game-based intervention can increase psychological flexibility among children when the need for an intervention is considered. Further research is necessary to examine the stability of improvements in psychological flexibility.

1. Introduction

A large portion of children and adolescents experience psychological problems. International research literature suggests that up to 20% of children and adolescents develop clinically significant depressive or anxiety symptoms by the age of 18 (Grist et al., 2019). Additionally, the global prevalence for psychological disorders has been estimated at 13.4% (Polanczyk et al., 2015). Despite these findings showing a need for mental health services, most children and adolescents receive no treatment (Kazdin, 2019). Alarmingly, in some reports, only approximately 50% of adolescents who experience severely impairing psychological disorders have received treatment (Merikangas et al., 2011). Furthermore, recent reports have suggested that the COVID-19 pandemic may have increased the need for psychological help among children and adolescents (e.g., Hafstad et al., 2021; Rogers et al., 2021). Large survey studies have found that the pandemic has harmed the quality of life and mental health of children and adolescents and that

factors such as low socioeconomic status and limited living space can increase the risk of psychological impairments (Ravens-Sieberer et al., 2021).

The high rates of child and adolescent mental health problems and low rates of young people who receive support call for new models and interventions to improve access and prevent the development of mental health disorders and improve well-being (Eyre & Thapar, 2014). Schools can identify children in need of support or treatment. However, developing new ways to offer early interventions is necessary to help them respond efficiently. This is particularly important as surveys indicate that many schools do not use evidence-based prevention programs to address behavioral and emotional difficulties in children (Gottfredson & Gottfredson, 2002; Ringwalt et al., 2009). Among the children and adolescents who do receive psychological help, up to 80% do so in school (Merikangas et al., 2011). In addition to psychological treatment, milder problems might also benefit from preventive interventions in nonclinical settings, particularly in schools and colleges (Kieling et al., 2011; Patel

et al., 2007). Furthermore, the ability of school psychologists and other school-based professionals to meet the mental health needs of schoolchildren is limited (Forman, 2019). It is thus necessary to consider alternative methods, including teachers delivering a mental health prevention program (Domitrovich et al., 2019; Forman, 2019). One approach to increasing access to psychological support is to utilize technology-based support models (Hollis et al., 2015).

Some research is available on previous universal programs to promote well-being. Large-scale programs delivered in schools have yielded mixed results. For instance, a large school-based universal intervention program targeted the resilience factors that reduce mental health problems in adolescents by having intervention schools provide 9 h of resilience-focused content as part of teaching activities and additional 9 h of resilience-focused content as part of other school activities (Dray et al., 2017). The study found no significant difference in mental health outcomes at follow-up between the intervention and the control group among the 12 to 16 years-old adolescents (Dray et al., 2017). Other universal, school-based interventions aimed at enhancing well-being have reported non-significant effects (e.g., Burckhardt et al., 2017; van der Gucht et al., 2017). However, school-based interventions where participants have been selected based on their need for an intervention have offered evidence of significant reductions in depression among high school students with elevated symptoms (Burckhardt et al., 2016). There is thus a need for more research examining preventive interventions that promote mental health and improve well-being in adolescents. It is possible that a ceiling effect in measures of symptoms and well-being can potentially cause difficulties in detecting the effects of universal prevention programs offered to young people many of whom do not experience symptoms. Thus, it may be important to pay attention to the variation and individual effects in school-based samples.

One approach to developing programs that are effective and easy to disseminate is using e-health technologies, such as games, which can extend the reach of mental health prevention and treatment (Kazdin & Blase, 2011). Using technology and mobile devices (e.g., smartphones, tablets) to deliver preventive programs offers new and flexible ways to reach large numbers of children and adolescents (Edwards-Hart & Chester, 2010). There is some evidence of technology-based interventions' effects in alleviating symptoms among young people. For instance, a meta-analysis investigating seven internet-based interventions for children and adolescents aged between 7 and 25 years indicated that such interventions, which included several types of delivery methods, were effective in reducing anxiety and ineffective in reducing depression (Ye et al., 2014). However, other reviews have suggested that internet-delivered interventions can be beneficial for both depression and anxiety. Clarke et al. (2015) review reported that while the number of high-quality studies investigating mental health outcomes was small, there was support for the efficacy of computerized cognitive behavioral therapy in reducing depression and anxiety among adolescents. In addition, Välimäki et al. (2017) have similarly reported in their review that web-delivered interventions are beneficial in reducing depression and anxiety among 10–24 years old participants, though more research is needed to evaluate their long-term effects. Moreover, the acceptance and commitment therapy-based Youth Compass intervention has been found to be effective in alleviating depression (Lappalainen et al., 2021) and stress (Puolakanaho et al., 2019) among adolescents.

In addition to internet-delivered interventions, mobile games hold great potential for enhancing motivation, interest, interaction, and engagement in children and adolescents (Koutromanos & Avraamidou, 2014). As games are originally a form of play or recreation, the term *serious* games is used to refer to games that are designed to achieve a purpose besides entertainment (Baranowski et al., 2016; Ritterfeld et al., 2009). *Therapeutic* mobile games are one form of serious game that can engage and motivate children and adolescents and offer them the opportunity to be exposed to contingency-based learning and acquire skills they can practice (Kato, 2008). The advantages of ease of use,

accessibility, and interactivity in the gamification process may make therapeutic games suitable tools for promoting mental health among children and adolescents (David et al., 2020). Therapeutic online games can be used both to prevent and address mental health concerns or health-related behavioral changes. However, as serious games have been seldom investigated, the evidence on them is mainly qualitative or focused on playability and acceptability (David et al., 2020). A recent systematic review and meta-analysis, which included 34 controlled studies, examined the efficacy of serious games in reducing symptoms of mental disorders and promoting health-related behavioral change (David et al., 2020). It found a small main statistical effect in favor of the intervention group receiving serious game intervention compared to the control group. These results suggest that serious games are likely not yet ready for dissemination as a stand-alone treatment/prevention strategy or as an adjunct to treatment-*as*-usual interventions aimed at reducing symptoms or promoting mental health and health-related behavioral change in children and adolescents (David et al., 2020). These findings call for the further development of technology-based interventions to help young people who experience psychological problems.

One potential approach to developing universal prevention programs for young people is acceptance and commitment therapy (ACT; Hayes et al., 2009), which has been shown to be effective in reducing psychological distress and behavioral problems and enhancing general well-being among children (Fang & Ding, 2020). ACT is a transdiagnostic third-wave cognitive behavioral therapy (CBT). Its goal is to increase psychological flexibility (i.e., the flexibility in responding to thoughts, feelings, and sensations), thus increasing the behavioral repertoire of an individual (Hayes et al., 2013). This is achieved through six core therapeutic processes: values clarification, committed action, acceptance, mindfulness, cognitive defusion, and self-*as*-context (Hayes et al., 2012). The construct of psychological flexibility is well suited for prevention purposes as ACT aims to enable living a meaningful life—not just reduce symptoms (Biglan et al., 2008). When applying ACT among adolescents and children, developmental adaptations are required to ensure age-appropriateness, such as increased behavioral activation, the inclusion of parents or peers, and tailored examples and explanations to support the understanding of abstract concepts (Halliburton & Cooper, 2015). It has also been suggested that children may benefit from the active use of metaphors and experiential exercises, which may allow them to grasp theoretical notions through experience (O'Brien et al., 2008). In the case of young people, ACT may remediate and prevent the onset of psychologically inflexible responses to inner events that lead to experiential avoidance strategies (Swain et al., 2015).

The use of ACT among adults has produced evidence of positive outcomes for a wide range of mental and physical health conditions and lifestyle changes (A-Tjak et al., 2015; Ruiz, 2010). However, there are limited data on applying ACT among children and early adolescents, with most of it coming from small samples and case studies. One of the few available reviews and meta-analyses has shown that a very small number of studies have included younger children and that most have focused on adolescents over 13 years of age (Swain et al., 2015). According to a review by Halliburton and Cooper (2015), ACT may be effective for adolescents with chronic pain, anorexia, depression, obsessive–compulsive disorder, post-traumatic stress disorder, stress, disruptive behavior disorders, learning disorders, and autism spectrum disorders. Others have concluded that ACT produces significant improvements in the majority of self- and clinician-reported clinical outcomes across presenting problems. However, limited research is available on ACT's core mechanisms of change among children (Swain et al., 2015). Finally, a recent meta-analysis, which included 14 randomized controlled trials with participants aged 2–21, found that among young people, ACT is more effective than treatment-*as*-usual or no treatment for depression, anxiety, and other mental and behavioral problems. It is not, however, superior to traditional CBT (Fang & Ding, 2020). In conclusion, more research on the effectiveness and underlying mechanisms of change in ACT among young people, particularly

younger children, is necessary to draw strong conclusions. More research is also needed on technology-based ACT interventions for children and adolescents.

The current study sought to evaluate the use of ACT in school settings to provide engaging mental health prevention programs to children. Specifically, the study wished to examine the effectiveness of a mobile game that uses dialogues and problem-solving tasks in introducing ACT-based conversations and exercises in a classroom setting. We thus investigated whether a four-session ACT intervention, which included the mobile game and game-related written tasks, was effective in improving psychological flexibility and well-being in a nonclinical sample of 10 to 12-year-olds. Furthermore, we were interested in examining the association between experiential avoidance and well-being among school-aged children at a general level (before the intervention was provided) and in relation to the observed changes during the intervention.

The study asked the following research questions:

1) Is the level of psychological inflexibility among 4th–6th-grade schoolchildren associated with the level of emotional and behavioral problems and health-related quality of life (HRQoL) and with self-rated mood, school satisfaction, loneliness, or friendships?
2) Is the game-based ACT intervention effective in decreasing psychological inflexibility and improving well-being among children who report high inflexibility at baseline?

Prior to the main analyses we examined the baseline level of the outcome variables and if there were baseline differences between the intervention groups and the control groups or between male and female participants that would require attention before performing the analyses. We hypothesized that psychological inflexibility would be associated with lower well-being and higher emotional and behavioral problems. Furthermore, we hypothesized that the intervention would be effective in decreasing inflexibility among those children who reported high inflexibility at baseline. Based on previous studies of universal, preventive interventions for well-being, we assumed that the intervention effect would be difficult to detect among children who do not report high inflexibility due to a floor effect on the measure of psychological inflexibility. Thus, we expected no intervention effect among children with already good flexibility skills (low inflexibility).

2. Methodology

The study was conducted in the fall of 2020 in elementary schools (grades 4–6) in Vaasa, Finland. The study was reviewed and approved by the University of Jyväskylä ethics committee in June 2020. In May 2020, an invitation letter was sent to all Vaasa regional schools ($N = 17$), welcoming participation in the study. The letter included information about the study's aims (i.e., promoting children's mental health by teaching well-being skills in schools). In the autumn of 2020, six schools (i.e., principals) agreed to participate in the study. Finally, seven teachers volunteered, and their six classes were recruited ($N = 123$ children; see Fig. 1). In one case, two teachers co-taught their classes, which were thus treated as one class. Written permission to participate in the study was required from both children and parents. Children whose parents declined participation or did not return the consent form ($n = 17$) did not participate in the study but did play the game, as the game sessions were arranged during regular teaching practice. The six classes were randomly assigned to the treatment group ($n = 3$) and the control group ($n = 3$). The mean age of the children in the intervention group was 11.07 and 44% were female. In the control group, the mean age of the children was 11.26 and 57% were female. The treatment group received the game-based intervention immediately after the baseline measures, while the control group only played the game after the posttreatment questionnaires had been collected.
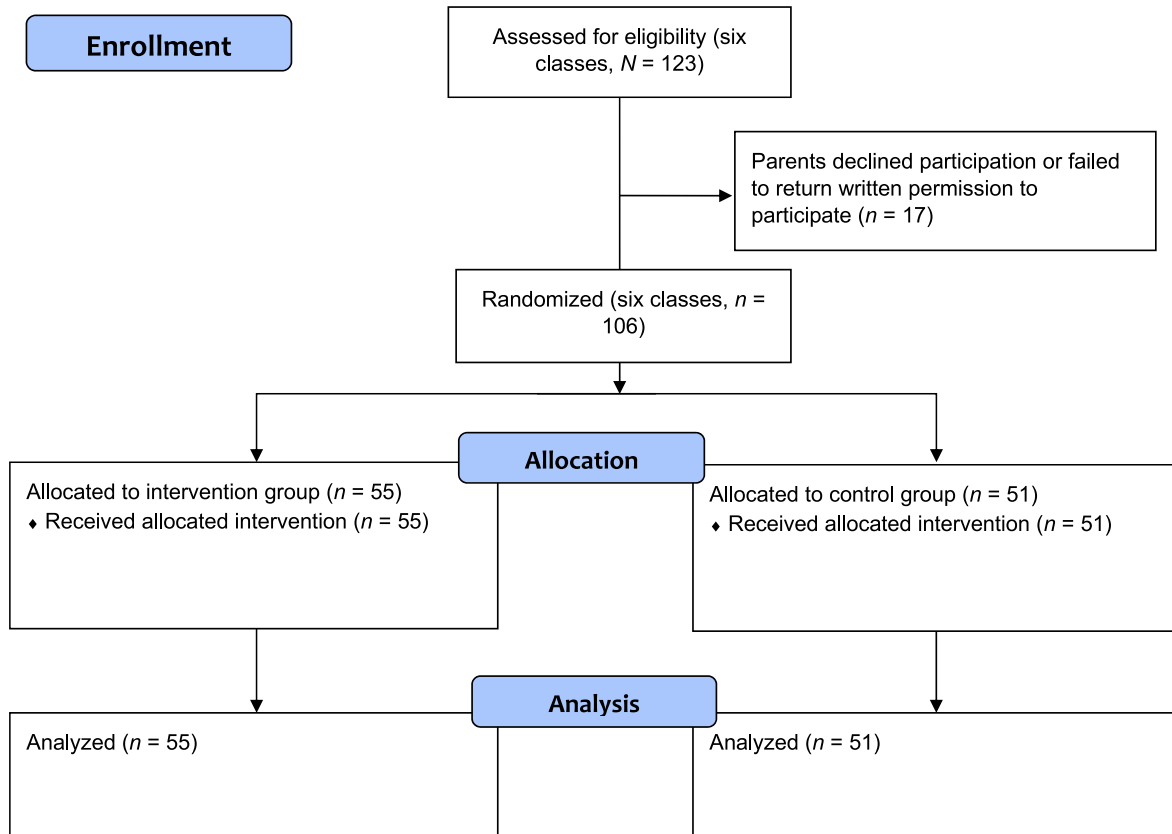

Fig. 1. Flow of participants.

3. Intervention

The game was used in the classroom, and game sessions were scheduled weekly during regular school hours. The game sessions were led by project workers involved in the research who were very familiar with the game and had playthrough directions in case any of the children got stuck. The teachers of the six participating classes were also present during the game sessions to assist the children. The game has four chapters that each take 30–45 min to complete (see Table 1 for chapter content). Each week, the class played through one chapter. In addition to the game content, the intervention included written tasks to be completed after each game session. The written tasks were designed to highlight important content and facilitate applying the presented material to everyday situations. The written assignments took 10–15 min to complete. For example, one of the assignments for Chapter 2 asked the player to write down which *Value Rune* they had chosen in the

Table 1
A summary of game content by chapter.

	Content	Themes	Dialogue examples
Chapter 1:	Acceptance, self-*as*-context, values and valued actions, defusion	Fear, self-critical thoughts, peer pressure and comparing to others, planning your actions	*"How can you remember not to listen to your angry thoughts next time?", "What kind of friend would you like to be?"*
Chapter 2:	Acceptance, self-*as*-context, valued actions, defusion	Bullying, anger and hate, fear	*"When you go along with your anger, you will often find yourself in trouble.", "It says to try and locate the feeling in your body. Where do you feel it?"*
Chapter 3:	Acceptance, defusion, values and valued actions	Adjusting to change, identifying and noticing your feelings, difficult thoughts, thoughts about others	*"Now that you've chosen courage, you can choose to be courageous even when afraid.", "When you feel like there are too many thoughts in your head, you can place them on leaves."*
Chapter 4:	Self-*as*-context	Responding to your feelings, prosocial behavior	*"It says: 'Just like the sky is a place for the weather, you are a place for your feelings.'", "I'll drink from the potion and describe the feeling. You choose the right label."*
Throughout the game:	Tracking, changing perspective (deictic framing), normalizing thoughts and feelings, metaphors	Helping others who struggle	*"If I were at the beach and you were on top of the mountain. If here were there and there were here, where would I be?", "Water can boil or it can freeze. Just like you might laugh or tease. But water is water, be it frozen or boiling. And you are you, no matter what thought in your head you might be voicing."*

game world's Rune Grove and plan one action they could do that would reflect their chosen value.

4. The game

Magis – A Magical Adventure is a mobile game that models psychological flexibility using dialogue and plot. The game has been designed to improve psychological flexibility skills among 10 to 12-year-old children. It was developed by an expert group (XX,XX,XX) with more than 10-year experience of construction and development of digital interventions. The construction was done under the supervision of the last author (XX), an expert in ACT with more than 20 years of experience in teaching, supervising, and practicing ACT. Several prototypes and versions of the game were tested at school context during a period of 6 months. The content, semantics, design, feasibility, and acceptability of the game was evaluated (for example using observations and interviews) and the game was modified and refined based on the feedback. The game asks the player to engage in ACT-based conversations with different characters in the game world (see Fig. 2). These conversations model how to process difficult thoughts and emotions, identify personal values, take values-based action, and take another person's perspective (see Table 1 for a summary of the themes). By improving psychological flexibility and related skills, the game also aims to improve overall wellbeing of the players. The game is free and available for download from the Google Play store and the AppStore globally. The supported languages currently include Finnish, Swedish, and English.

5. Measures

Three questionnaires were used to measure psychological inflexibility (Avoidance and Fusion Questionnaire for Youth, AFQ-Y8), emotional and behavioral symptoms (Strengths and Difficulties Questionnaire, SDQ), and Health-Related Quality of Life (HRQoL/KINDL). Participants also filled out brief self-rating visual analog scales (VAS) for mood, school satisfaction, loneliness, and friendships. Baseline questionnaires were completed during the week prior to the intervention in classrooms in schools. Post-treatment questionnaires were filled out in the week after the intervention also in the classroom environment. The measures were thus completed approximately five weeks apart. The children completed the questionnaires themselves, but the researchers and the teacher helped if necessary. The pen and paper questionnaires were checked to ensure all items had been answered. The few missing responses that were still identified, were replaced with the mean values of the questionnaire's items if at least 50% of the items had been filled in. This strategy was selected based on the recommendation of a statistician who was consulted on the matter of missing data. Thus, for the AFQ-Y8, mean values for items that were rated were used to calculate the total score if at least four out of eight items had been rated. For the SDQ and the KINDL, 50% of each of the subscales were required to have been rated. Most variables had 2-5 missing responses for individual items of the scale. The highest amount of missing item-level responses was the SDQ peer relationships subscale, where nine participants had failed to respond to all items at baseline. However, eight out of these nine participants had responded to at least 50% of the items for the subscale and their score was calculated using the mean value of the items they had rated.

Avoidance and Fusion Questionnaire for Youth (AFQ-Y8; Greco et al., 2008) is a measure of psychological inflexibility for children and adolescents. The scale has eight items that focus on the processes of psychological inflexibility, cognitive fusion (e.g., "The bad things I think about myself must be true"), experiential avoidance (e.g., "I am afraid of my feelings"), and inaction or behavioral ineffectiveness in the presence of unwanted internal experiences (e.g., "I stop doing things that are important to me whenever I feel bad"). Each item is rated for how true it feels to the responder on a scale of 0–4, where 0 = *not at all true* and 4 = *very true*. The AFQ-Y8 scores are obtained by summing all eight items

Fig. 2. Players engage in ACT-based conversations. The example above models how to respond to difficult thoughts.

(min. 0, max. 32). Lower scores indicate better outcomes, that is, less inflexibility (Valdivia-Salas et al., 2017). The internal consistency of the AFQ-Y8 was acceptable in the current sample (α = 0.79, 8 items).

The Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997) is a measure of emotional and behavioral problems that focuses on five domains: emotional symptoms (5 items, e.g., "I worry a lot"), conduct problems (5 items, e.g., "I usually do as I am told"), hyperactivity/inattention (5 items, e.g., "I am easily distracted"), peer relationship problems (5 items, e.g., "I am usually on my own"), and prosocial behavior (5 items, e.g., "I usually share with others"). The current study used the self-report version of the scale, which has a slightly modified wording (Goodman et al., 1998). Each item is rated on a scale of 0–2, where 0 = *not true*, 1 = *somewhat true*, and 2 = *certainly true*. The total difficulties score is calculated by summing the score of all the domains except the prosocial one. The total score ranges between 0 and 40, with higher scores indicating more behavioral and emotional problems. The internal consistency of the SDQ in our sample was good (α = 0.82, 20 items).

Health-Related Quality of Life (KINDL; Erhart et al., 2009) is a measure of health-related quality of life for healthy and ill children and adolescents. The Kid-KINDL version of the scale for children aged 7–13 was used in the current study. The scale consists of 24 items associated with six dimensions: physical well-being (4 items, e.g., "I felt ill"), emotional well-being (4 items, e.g., "I had fun and laughed a lot"), self-esteem (4 items, "I was proud of myself"), family (4 items, e.g., "I got on well with my parents"), friends (4 items, e.g. "I played with friends"), and everyday functioning (4 items, e.g., "Doing schoolwork was easy"). The additional disease module for ill children was not used in the current study. Each item is rated on a 5-level Likert scale, where 0 = *never* and 5 = *all the time*. Higher scores on each dimension of KINDL indicate a higher health-related quality of life. The internal consistency of the KINDL was good in the current sample (α = 0.85, 24 items).

VAS scales were used to evaluate mood, school satisfaction, loneliness, and friendships. Regarding mood, participants were asked to rate "How have you felt in the past few days?" on a scale of 1–5 (1 = *very bad*, 5 = *very good*). For school satisfaction, participants were asked to rate "How do you like going to school at the moment?" on a scale of 1–5 (1 = *not at all*, 5 = *very much*). Concerning loneliness, participants were asked to rate "Do you feel lonely?" on a scale of 1–3 (1 = *often*, 3 = *not at all*). For friendships, participants were asked to rate "How many good friends do you have?" on a scale of 1–3 (1 = *none*, 3 = *two or more*).

6. Statistical analyses

All statistical analyses were performed using the IBM SPSS Statistics software. First, baseline level of the measures and possible differences between the participants allocated in the intervention and control groups were analyzed using independent samples t-tests with the treatment group as a grouping variable. Possible differences between male and female participants were also examined using independent samples t-tests with gender as the grouping variable. The associations between the level of psychological inflexibility and the level of emotional and behavioral problems, HRQoL, self-rated mood, school satisfaction, loneliness, and friendships were examined using Pearson's correlation coefficients. The effect of the intervention was then analyzed using repeated measures multivariate analysis of variance (MANOVA) analysis, first for the psychological questionnaires and then for the VAS scales, with the treatment group as a grouping variable. In further analysis, a baseline psychological inflexibility grouping variable was created by dividing the participants into three groups based on the observed distribution of scores in the current data. The baseline inflexibility classification was then used as a covariate in further repeated measures MANOVA analyses. Finally, the relationship between baseline inflexibility classification and changes during the intervention was examined using parallel paired samples t-test analyses for the classes in both the intervention and the control group.

7. Results

7.1. Baseline psychological inflexibility, HRQoL, and well-being

The children in the sample were not identified as having mental health problems, which was reflected in the mean levels of the well-being measures. However, a large variation was observed among the participants. The levels of psychological inflexibility (AFQ-Y8), Health-Related Quality of Life, HRQoL (KINDL), and well-being, including emotional and behavioral problems (SDQ), mood, school satisfaction, loneliness, and friendships (VAS scales), are presented in Table 2.

There were no significant differences between participants in the intervention group and the control group on any of the measures. A significant difference was observed between girls and boys in self-rated school satisfaction—girls reported higher satisfaction (M = 3.90 for girls and M = 3.49 for boys, t (102) = 2.34, p = .021). No other gender differences were observed. The gender difference in one of the VAS scales was deemed a minor difference and it was not controlled for in for further analysis.

Table 2
Descriptive values for baseline experiential avoidance, emotional and behavioral problems, quality of life, and the VAS scales for mood, school satisfaction, loneliness, and friends satisfaction.

	N	Min.	Max.	Mean	SD	95% CI
AFQ-Y8	105	0	26	6.55	5.37	5.58; 7.68
SDQ	104	1	23	9.53	5.47	8.50; 10.64
KINDL	104	56	114	95.26	12.16	92.87; 97.64
Mood	106	1	5	3.99	0.97	3.82; 4.19
School	106	1	5	3.69	0.91	3.51; 3.87
Loneliness	106	1	3	2.68	0.50	2.60; 2.79
Friends	106	1.50	3.00	2.95	0.22	2.91; 3.00

7.2. Association between psychological inflexibility and measures of well-being

A high ($r > 0.55$) or close to high ($r > 0.45$) correlation was found between psychological inflexibility, Health-Related Quality of Life, and all the measures of well-being (SDQ and VAS scales) except for friendships (see Table 3). In all cases, the direction of the relationship was as expected. The findings suggest that psychological inflexibility was associated with higher psychosocial symptomatology and lower life satisfaction. Psychological inflexibility was also associated with poorer self-rated mood and school satisfaction and higher loneliness. Psychological flexibility was not associated with friendships, however.

7.3. Intervention effect: psychological inflexibility and well-being

A repeated measures MANOVA was used to examine between-group differences in changes in psychological inflexibility (AFQ-Y8) and well-being during the intervention, as measured by the SDQ. There were no significant interactions between time and group for any of the psychological questionnaires. Among the self-rated VAS scales, there was a significant interaction for loneliness ($F (1,102) = 5.77, p = .018$). The descriptive values for the intervention and the control condition suggest that the intervention group experienced a small decrease in loneliness during the intervention, while the control group experienced an *increase* in loneliness.

To further examine individual differences and if the large variation in baseline psychological inflexibility was associated with changes during the intervention that targeted flexibility skills, additional analyses were conducted. We expected that the effect of the intervention would be different among participants with a lower/higher need for psychological flexibility skills training. The participants were divided into three groups based on the distribution of the AFQ-Y8. Participants who scored 0–3 on AFQ-Y8 were allocated to group 1 (flexible kids, 35.2%). Participants who scored 3–7 points were allocated to group 2 (moderately inflexible kids, 32.4%). Finally, participants who scored 8–26 were allocated to group 3 (highly inflexible kids, 32.4%). The third group's level of psychological inflexibility (≥ 8 points) corresponds to the mean level of inflexibility reported in school-based samples ($M = 8.93, SD = 6.32, N = 515$; Greco et al., 2008). This suggests that our sample had less psychological inflexibility than that reported in larger samples in this age group. For the current analysis, the grouping was used as a covariate in a repeated measures analysis of variance (ANOVA) analysis. A significant interaction was thus found between time and the baseline level of psychological inflexibility ($F (1,102) = 9.58, p = .003$). However, the interaction between group (intervention/control) and time was not significant ($F (1,102) = 2.33, p = .130$). The descriptive values for pre- and post-measurements for the intervention group and the control group are presented in Table 4.

As hypothesized, we expected to detect changes among children who reported high inflexibility. To examine how baseline inflexibility was associated with changes during the intervention, the intervention group and the control group were analyzed separately using paired-samples t-tests with the baseline inflexibility grouping. The results suggest that participants in the intervention group who were highly inflexible (group 3) at baseline experienced significant decreases in psychological inflexibility during the intervention ($t (16) = 1.86, p = .041, d = 0.35$). This effect was not observed in the control group. However, participants who were classified as flexible kids at baseline experienced a statistically significant *increase* in psychological flexibility ($t (21) = -2.43, p = .012, d = 0.29$). This finding suggests that participants with very low inflexibility may experience a measuring effect that influences how they evaluate their flexibility skills. This conclusion is supported by the findings of the control group. Similarly, participants in the control group who reported very low inflexibility at baseline (score 0–3) experienced an increase in inflexibility during the waiting-list period ($t (14) = -2.21, p = .022, d = 0.15$). The within-group changes are presented in Fig. 3. In both the intervention and the control group, the level of inflexibility remains very low despite the statistically significant increases among participants who report very low inflexibility at baseline.

8. Discussion

This study aimed to examine the effects of a brief, game-based intervention on the psychological flexibility skills of 10 to 12-year-old children ($n = 106$). The intervention was delivered in school settings,

Table 4
Descriptive values for the pre- and post-measures of behavioral and emotional problems, quality of life, self-rated mood, school satisfaction, loneliness, and friendship satisfaction.

	Pre-measurement		Post-measurement	
	Intervention group M (SD)	Control group M (SD)		Intervention group M (SD)
SDQ	9.55 (5.53)	9.51 (5.47)	10.50 (6.48)	9.31 (5.08)
KINDL	94.81 (12.40)	95.74 (11.99)	94.06 (14.53)	94.64 (12.34)
Mood	3.94 (1.00)	4.08 (0.92)	4.06 (1.10)	4.05 (0.78)
School	3.62 (0.97)	3.79 (0.86)	3.59 (1.13)	3.74 (0.96)
Loneliness	2.71 (0.49)	2.67 (0.52)	2.78 (0.43)	2.54 (0.56)
Friends	2.94 (0.27)	2.97 (0.16)	2.90 (0.32)	2.98 (0.14)

Table 3
Pearson correlation coefficients for the association between experiential avoidance, psychosocial symptoms, and quality of life at baseline.

		AFQ-Y8	SDQ	KINDL	Mood	School	Lonelin.	Friends
AFQ-Y8	Psychological inflexibility	1						
SDQ	Emotional and behavioral problems	.63[a]	1					
KINDL	Health-related quality of life	−.54[a]	−.72[a]	1				
Mood	VAS	−.55[a]	−.61[a]	.78[a]	1			
School	VAS	−.46[a]	−.48[a]	.63[a]	.60[a]	1		
Loneliness	VAS	−.46[a]	−.55[a]	.53[a]	.59[a]	.43[a]	1	
Friends	VAS	−.09	−.20*	.25*	.27[a]	.12	.38[a]	1

[a] Correlation is significant at the .01 level (2-tailed). *Correlation is significant at the .05 level (2-tailed).

Fig. 3. Changes in psychological inflexibility during the brief game-based intervention among flexible kids, moderately inflexible kids, and highly inflexible kids (nine points cutoff).

and the children represented a nonclinical, school-based sample who received the intervention as part of usual teaching activities. Large variation was observed in measures of psychological inflexibility and well-being. The results suggest that psychological inflexibility was associated with health-related quality of life, emotional and behavioral problems, self-rated mood, school satisfaction, and loneliness. The observed associations indicate that psychological flexibility skills may be an important intervention target among schoolchildren.

As for the effects of the intervention, we did not detect an effect on psychological flexibility or health-related quality of life among the whole intervention group. However, the results suggest that the intervention was effective in alleviating self-rated loneliness in the intervention group. More research is necessary to understand the mechanism of change underlying the observed effect on loneliness.

In further analyses, the intervention was found to have different effects on psychological inflexibility among children with varying levels of psychological inflexibility at baseline, i.e., among children with varying needs for the intervention. A significant interaction between time and baseline psychological inflexibility was found in further analyses that aimed to understand the development of flexibility skills during the intervention. Parallel analysis of flexible kids, moderately inflexible kids, and highly inflexible kids suggests that the intervention was effective in decreasing psychological inflexibility among children who had high inflexibility at baseline, but not among flexible kids or moderately inflexible kids (score 0–7 in the AFQ-Y8) before the intervention. This finding is in line with previous research on universal interventions for nonclinical samples that have failed to demonstrate significant effects among children who have not been identified as having low well-being (e.g., Burckhardt et al., 2017; van der Gucht et al., 2017).

Two factors should be considered when interpreting these results. First, the available scales may not be sensitive enough to detect changes among participants who have high well-being. Second, it may be more important to demonstrate that universal interventions are effective among children who *do* experience emotional or behavioral problems than to increase already high well-being. Schools play a central role in supporting children and adolescents, but resources to identify risk factors and intervene in developing mental health problems are limited (Forman, 2019). Therefore, scholars have called for technology-based, universal interventions that can be offered to large groups of children and that are effective in alleviating symptoms for those who are at risk or who experience ill-being (e.g., Kazdin & Blase, 2011). The current study suggests that ACT-based mobile games could be one alternative to offering early interventions.

Interestingly, the children who scored 0–3 on the AFQ-Y8 at baseline experienced an *increase* in psychological inflexibility in both the intervention group and the control group. This could reflect a measurement effect (i.e., measuring psychological inflexibility may influence self-

ratings of the associated skills). It should be noted that previous reports of 5th–6th-grade schoolchildren samples have reported higher mean levels of psychological inflexibility than those found in the current sample ($M = 8.93$, $SD = 6.32$, $N = 515$ in Greco et al., 2008, vs. $M = 6.55$, $SD = 5.37$ in the current sample). Thus, the increase in inflexibility among children with very low scores could reflect more accurate self-ratings after the intervention. It is also possible that the Finnish version of the AFQ-Y8 is less sensitive than the original English scale. Future research should aim to increase sensitivity in the lower range of inflexibility so that the reliability of self-rated scales of psychological inflexibility for young people may be strengthened.

This study has several limitations. First, the sample is relatively small; the subsample analysis should thus be interpreted with caution. Second, the data were collected during the COVID-19 pandemic, but the impact of the pandemic and related disruptions to school and home life cannot be accounted for. Third, the current design did not include a follow-up phase; the long-term effect of the intervention cannot thus be established. Finally, the classification for baseline inflexibility was rooted in the observed distribution of the current sample. For this reason, the results should be replicated to understand how higher/lower inflexibility moderates the impact of the intervention in larger samples.

Previous research has concluded that technology-based interventions may be effective in alleviating symptoms of poor mental health among children and adolescents (Clarke et al., 2015; Välimäki et al., 2017). However, using serious games as a delivery method for interventions aimed at improving well-being has not yielded significant results. Further investigation has thus been called for (David, 2020). The current study suggests that a brief, game-based ACT intervention can be beneficial to children with existing risk factors for well-being (i.e., high psychological inflexibility). Furthermore, such an intervention may decrease loneliness. Future research should examine how game-based interventions that are motivating, easy to disseminate, and inexpensive for schools could be developed to serve both children with emotional or behavioral problems and children who do not currently exhibit symptoms. If risk factors and early development of mental health problems cannot be efficiently screened and responded to, universal interventions that target unidentified children may be needed to support young people facing difficulties.

Data availability

Data is available upon reasonable request.

Declaration of competing interet

Given their role as Editorial Board Members, Lappalainen P. and Lappalainen R. had no involvement in the peer-review of this article and had no access to information regarding its peer-review. All other authors

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