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Motivation Profile and Wellbeing in Transylvanian Hungarians with Type 2 Diabetes

Kármén SULYOK¹, Kinga KÁLCZA-JÁNOSI^{1*}, Ibolya KOTTA¹

ABSTRACT. Diabetes is a complex endocrine disease with a series of complications and it represents a significant public health concern globally and regionally in Romania. Specific aspects of motivation as well as mental wellbeing are considered to be related to diabetes management. When the psychological needs are supported, people experience better quality motivation, higher sense of wellbeing and tend to maintain desirable behaviors. Our objective was to examine the predictive role of motivation and wellbeing variables on glycemic control in patients diagnosed with type 2 diabetes in Transylvania, Romania. We also targeted other relevant factors (demographic parameters, clinical illness characteristics, diabetes-related knowledge) which influence optimal glycemic control. Participants (N=232) were Hungarian speaking adult patients from Transylvania, Romania, diagnosed with type 2 diabetes. Demographic and clinical data sets were collected. Participants completed a set of questionnaires developed to measure motivational dimensions, subjective wellbeing and diabetes-related knowledge. Targeted motivation variables were established based on Self-Determination Theory. The study followed an observational correlational design. Hierarchical multiple regression models were used to investigate the predictors of glycemic control. Results show that perceived competence and autonomous motivation have increased predictive power on optimal glycemic control, but the effect of motivation is partially mediated by wellbeing components. Illness related characteristics like vascular complications, comorbidities and illness duration proved to be essential predictors of glycemic control. Illness duration seemed to have a specific effect on glycemic control for patients living in Transylvania, longer duration predicts better glycemic control. Future research should examine the topic using an experimental design.

Keywords: type 2 diabetes, glycemic control, autonomy, competence, relatedness, wellbeing, illness characteristics, diabetes-related knowledge

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Introduction

Diabetes is a complex endocrine disease with a series of complications, and it represents a significant public health concern globally and regionally in Transylvania, Romania. In a 2016 report the World Health Organization has estimated the number of diabetes patients would reach 425 million by 2017, with a global prevalence in the adult population rising to 8.5% (WHO, 2016). Negative effects of diabetes have been linked to poor glycemic control reflected in high glycosylated hemoglobin (HbA1c) levels, which are associated with substantial morbidity and mortality rates. Recent studies have shown a significant rise in the number of diabetic patients in Romania (Mota & Dinu, 2013; Roșu & Moța, 2018). Results of an extensive study published by the Romanian Society of Diabetes, Nutrition, and Metabolic Diseases stated that in 2014 there were nearly 2 million Romanian citizens suffering from diabetes mellitus (IDF Diabetes Atlas 9th Edition 2019, n.d.; Mota & Dinu, 2013).

According to the International Diabetes Federation (IDF) data, the age-standardized prevalence of diabetes in Romania was 8.4%, with approximately the same rates for men and women (International Diabetes Federation - The Programme, n.d.). However, the first large scale national study on the occurrence of diabetes in Romania (PREDATORR) recorded an elevated, 11.6% age- and sex-adjusted rate (Roșu & Moța, 2018), almost double compared to previous estimations (Mota & Dinu, 2013).

Complications related to diabetes can be prevented by appropriate treatment, lifestyle changes and regularly performed self-management tasks, such as maintaining a healthy diet, self-monitoring blood sugar levels, adjusting insulin doses and medication. Patient self-management was considered to be reflected in the level of glycemic control; a variable found to be associated with the harmful effects of the condition (Egwim, 2022). Good glycemic control was indicated by a HbA1c level lower than 7%, with values over being perceived as reflecting poor control ("Glycemic Targets: Standards of Medical Care in Diabetes—2018", 2017).

Although various factors have been described to predict poor glycemic control (Ross et al., 2011; Yasmin, Al-Zahraa, 2023), evidence is lacking on specific predictors and mediating factors associated with this variable among patients with type 2 diabetes in Romania.

Diabetes-Related Knowledge and Diabetes Management

The self-management of diabetes was described as one of the most complex challenges in the treatment of this chronic disease. Diabetes-related knowledge has been considered an important prerequisite in preventing disease related complications. Educated patients were found to manage the disease better than those unable to understand it and its symptoms (McPherson et al., 2008). Strine et al. (2005) reported that 50-80% of diabetes patients worldwide have significant knowledge gaps regarding their disease. Some evidence-based studies suggested that patients with diabetes complications often lack adequate knowledge about the nature of the disease, risk factors and associated complications (Menwer Alanazi et al., 2017; Sivaganom et al., 2002; Strine et al., 2005). Although there is significant literature on the detrimental effects of a lacking diabetes education, studies on the relationship between diabetes-related knowledge and complications of the disease have reported conflicting results (e.g. Menwer Alanazi et al., 2017; Ozcelik, 2010). Lack of awareness is considered to be a contributing factor in patients manifesting inappropriate attitudes towards diabetes care and treatment. Similarly, McPerson et al. (2008) and Ozcelik et al. (2010) have found a strong inverse correlation between diabetes-related knowledge and HbA1c values, which reflects a better glycemic control.

Diabetes-related knowledge is considered important, but there were also results demonstrating that it is not the best predictor of glycemic control; diabetes education programs have shown mixed results in effectiveness (Adarmouch et al. 2017; Dube et al., 2015).

Several studies presented a lack of association between diabetes knowledge and different aspects of glycemic control (Arora et al., 2011; Formosa, 2008; He & Wharrad, 2007), but managed to find correlations with other associated variables (e.g. disease duration) or demographic characteristics of patients (e.g. level of education) (Arora et al., 2011).

Basic Psychological Needs and Diabetes Management

Self-determination theory (SDT) (Deci & Ryan, 2000) is a macro-theory of human motivation which posits that people are innately oriented towards attaining their physical and mental wellbeing and are more prone to adopt behaviors conducive to this state when basic psychological needs for *autonomy, competence and relatedness* are socially accepted (Williams et al., 2009). According to SDT, motivation is a psychological energy directed at a particular goal. When the psychological needs are supported by the social surroundings, people experience better quality motivation, higher sense of wellbeing and are more likely to maintain desirable behaviors.

Because of the way it explores the autonomous and self-determined characteristics of individual behavior (Deci, & Ryan, 2004), the theory was considered an excellent model for understanding chronic disease management (Williams et al., 2004). SDT identifies several distinct types of motivation, each impacting learning, performance, personal experience and wellbeing (Ryan & Deci, 2000a). The theory has been applied to explore different health-related behaviors in 184 data sets from around the world (Ng et al. 2012), for example the motivational basis for committing to long-term prescription drug treatments (Williams et al., 2005). Based on previous empirical results there was a positive link between patient autonomy and health (Ng et al., 2012). A recent study conducted with cluster randomized control trial method revealed that autonomy support groups working within the SDT frame could help patients not only achieve a better glycemic control, but also maintain it for a longer period of time (Yun et al., 2020).

SDT posited the three basic psychological needs as universal, underlining that the satisfaction of each may differ from one culture to another (Deci & Ryan, 2000). Research data has since confirmed that these psychological needs are indeed universal (Chirkov et al., 2005) but self-determination was also linked to culture (Moneta, 2004).

Mental Wellbeing and Diabetes Management

The concept of mental wellbeing was developed in the context of positive psychology and represents a complex psychological construct influenced by positive psychological characteristics (e.g. optimism, positive affect) and related constructs. According to the WHO, mental health and wellbeing are treated as equivalent concepts (WHO, 2005). In mental health service, mental wellbeing has been used as an outcome measure.

In psychological research, wellbeing was described as comprising positive emotional states (feeling good) and good functioning (thoughts on good functioning), specifically having a command over resources or achieving a balance between resources and challenges. From a multi-disciplinary point of view, wellbeing has been presented as a concept focused on optimism which can be described as the balance point between the resources and the challenges of an individual (Wassel & Dodge, 2015). This balance might have an important influence on health-related behavior and specifically diabetes management.

Self-efficacy, optimism and resilience in diabetes patients have been correlated with numerous beneficial outcomes (Al-Khawaldeh et al., 2012; Celano et al., 2013; Roberston et al., 2012; Venkataraman et al., 2011). These positive constructs have been associated with superior medical outcomes,

including better glucose control and lower mortality rates (Massey et al., 2017). Higher levels of overall wellbeing in patients with diabetes were correlated with better glucose control (Papanas et al., 2010). Also, better measures of emotional vitality and life satisfaction were associated with a more effective prevention of type 2 diabetes (Boehm et al., 2015).

Though the relationship between positive psychological constructs and health outcomes is not fully understood, most evidence that linked positive states to superior outcomes emphasized an increased adherence to health behaviors (Al-Khawaldeh et al., 2012; Roberston et al., 2012; Venkataraman et al., 2011).

Objectives

Our first objective is to examine the motivational profile of Hungarian speaking Romanian patients with type 2 diabetes living in Transylvania, within the theoretical framework of SDT. In addition, we aim to identify other variables (demographic parameters, clinical illness characteristics and diabetes-related knowledge) which could predict health maintaining behavior of patients with diabetes living in the socio-cultural background of Transylvania, Romania. Our second major goal is to examine the role of mental wellbeing as a mediator in the relationship between motivation and glycemic control.

Materials and Methods

Participants

Patients were sampled from 9 public hospitals in Transylvania, Romania, using a systematic sampling method. The patients were recruited from four randomly chosen counties (62% from Harghita, 18% from Mures, 12% from Covasna and 8% from Satu Mare).

They were asked to complete paper-based questionnaires during a screening visit.

The initially selected 317 participants were included in the sample based on the following criteria: Hungarian speaking adults (over 18 years), diagnosed with type 2 diabetes according to the standards of the American Diabetes Association (“Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes—2020,” 2019).

In order to reach our targeted sample, the following exclusion criteria were applied: 1) recent history of hypoglycemic coma; 2) primary neurological condition as history of transient ischemic attacks, cerebrovascular stroke,

epilepsy or psychiatric disease; 3) previous severe head injury; 4) any sensory or motor disorder that would preclude questionnaire completing; 5) regular treatment with any medications known to have psychoactive effects and 6) drug or alcohol abuse.

Based on our exclusion criteria, 278 subjects were found to be eligible. After completing the outlier identification (see section *Data processing and statistical analysis*) a number of 232 (N=232) participants were recruited.

Power and sample size

A priori power analysis was performed using G_Power3 for hierarchical linear regression (total number of predictors 11) with a p-value of 0.05 and statistical power of 0.95. Results showed that for a medium effect size ($f^2 = 0.15$) (Faul et al., 2009) the required sample size is $n = 178$. Recommended effect sizes used for this assessment were as follows: small ($f^2 = .02$), medium ($f^2 = .15$), and large ($f^2 = .35$). The sample size of the study ($n = 232$) proved to be suitable for detecting medium effect sizes.

Ethics Statement

Our study used questionnaires to assess self-management behaviors, socio-demographic and clinical characteristics of patients. Data regarding biomedical parameters was extracted from the participants' medical records. All participants gave written informed consent after being provided a complete description of the study.

Methods and procedures were implemented as requested by the Guideline of the Code of Deontology for the Profession of Psychologist, elaborated by the Romanian College of Psychologists (COPSI).

Measurements

Demographics

Participants provided information about their sex, age, education, marital status and perceived economic status.

Clinical Assessment

Participants were asked to provide demographic data and medical history of diabetes. *Diabetes control* was measured using glycosylated hemoglobin (HbA1c) level measurements. Information regarding the last HbA1c value was collected from the medical records provided by the general practitioners with

the patients' consent. The test indicates the level of glycemic control over a 3-month period. Poor diabetes control was defined by a HBA1c $\geq 7\%$ according to the guidelines on glycemic targets for diabetes control ("Glycemic Targets: Standards of Medical Care in Diabetes—2018," 2017). Furthermore, we collected data about *treatment type* (insulin, oral medication or nothing) and *disease duration* (number of years since type2 diabetes was diagnosed). A *comorbidities/complications* number was calculated based on the count of "Yes" answers given by participants on a list. List of comorbidities included: hypertension/heart diseases, dyslipidemia, liver disease, other chronic diseases, combination of aforementioned diseases and microvascular complications (retinopathy, neuropathy).

Instruments

In order to measure motivational dimensions, subjective wellbeing and diabetes-related knowledge, the following instruments were used:

To assess the motivational components of subjects we used the *Self-Determination Theory Questionnaire Packet for Diabetes* (Kálcza et al., 2016). The packet evaluates SDT constructs through 3 questionnaires.

Treatment Self-Regulation Questionnaire-Diabetes (TSRQ-D): assesses the individual differences specific to types of motivation or regulation (Autonomous Regulation Subscale and Controlled Regulation Subscale). Autonomous Regulation scores are represented by the average score given on autonomous items. Controlled Regulation scores are calculated from the average score of controlled items. Relative Autonomy Index (RAI) is calculated by subtracting the mean of Controlled Regulation scores from the mean of the Autonomous Regulation scores.

Perceived Competence for Diabetes Scale (PCDS) assesses feelings related to healthy behaviour, showing the degree to which patients feel they effectively manage diabetes in everyday life.

Modified Health Care Climate Questionnaire for Diabetes (mHCCQ-D) assesses how patients perceive their relationship with the medical staff and their perception over healthcare providers being autonomy supportive rather than controlling in consultations.

Patients evaluate on a 7-point Likert scale the degree to which the statements describe them, 1 meaning "strongly disagree" and 7 representing "strongly agree". For PCDS-HU and mHCCQ-D-HU questionnaires, scores range from 1 to 7, the final score is reached using averages. Because RAI-index is calculated by subtracting the average score of one 7-point Likert-type subscale from another, its range spreads from -6 to +6. Higher scores suggest a higher level on the measured dimensions.

The psychometric properties of the Hungarian scales used in our study were very good (TSRQ-D-HU Autonomous Regulation Subscale $\alpha = 0.82$ and $\alpha = 0.92$ at Controlled Regulation Subscale; PCDS-HU $\alpha = 0.87$; mHCCQ-D-HU $\alpha = 0.85$), they replicated those of the English version (Kálczá-Jánosi et al., 2017).

In order to evaluate the mental wellbeing of patients, we used The *Short Warwick Edinburgh Mental Well-being Scale (SWEMWBS)* (Stewart-Brown & Mohammed, 2001). The instrument presents a more restricted view of mental wellbeing than the original scale, with most items representing aspects of overall psychological and specifically eudaimonic wellbeing, and a few covering hedonic wellbeing or affect (Stewart-Brown et al., 2009). The scale has been validated for young people aged 15-21 (McKay & Andretta, 2017; Ringdal et al., 2018) and the general population (Ng Fat et al., 2017). The 7 items are positively worded with five response categories from 'none of the time' to 'all of the time'. Scores range from 7 to 35, higher scores indicate an elevated positive mental wellbeing. Previous research found the SWEMWBS to show adequate internal consistency ($\alpha = 0.83$) (Rogers et al., 2018).

Participants also completed the *Diabetic Knowledge Questionnaire - 24 (DKQ-24)* (Garcia et al., 2001). The DKQ 24-item version was developed from the original DKQ-60. The instrument assesses knowledge about the causes, types, self-management competencies and complications of diabetes. When calculating the knowledge score, 1 point is given to a correct answer, while 0 indicates an incorrect one. Scores range from 0 to 24, higher scores indicate a more accurate knowledge regarding diabetes.

The Hungarian version of the DKQ-24 presented good reliability with a Cronbach alpha index of 0.74 (Kálczá-Jánosi, et al., 2013).

Data Processing and Statistical Analysis

The study followed an observational, correlational design. To establish the relationship between the aforementioned factors we performed calculations using SPSS (Statistical Package for the Social Sciences) version 23.0.

In the first stage the Z-score method of outlier detection was performed, every value too far from zero (between -3 and 3) was considered an outlier and was removed from the database. All data was presented as mean (M) and standard deviation (SD) for continuous variables and as frequency/percentage for categorical variables. A probability (p) value ≤ 0.05 was considered statistically significant.

Hierarchical multiple regression models were used to investigate the predictors of glycemic control. The variables for regression models were chosen on a theoretical and statistical basis.

Violations of the normality assumption were checked using Shapiro-Wilk's test. All continuous variables (except autonomous motivation index) were transformed by square-root transformation (moderately, positively skewed data and moderately, negatively skewed data). Categorical variables were introduced as dummy variables. The Durbin Watson statistic was used to test the autocorrelation in the residuals from the statistical regression analysis. Linearity, homoscedasticity and multicollinearity were checked for the assumption that they relate to how the data fits the multiple regression model.

For the model, first we have introduced our control variables: baseline patient factors, including demographics (age, sex, education, marital status, economic status). In the second step illness variables (diabetes duration, treatment, comorbid diseases, vascular complications, diabetes related knowledge) were added. In a third stage we introduced the targeted variables represented by motivational factors (climate, perceived competence and autonomous motivation related to diabetes management) and finally perceived wellbeing was included.

Mediation analyses were performed to test the mediating role of wellbeing in the association between autonomous motivation and glycemic control using the PROCESS macro (Model 4) for SPSS version 3.5 (Hayes, 2018). Additionally, the bootstrapping method (10,000 resamples, 95% confidence intervals (CI)) was conducted to check for the significance of the indirect effects. Significance level of $p < 0.05$ was used for all analyses.

Results

Preliminary analysis

There were 232 type 2 diabetes patients included in the study, the youngest being 41, the oldest 77 years old. The age range can be explained by the age-specific characteristics of type 2 diabetes. 46.6% of participants presented a good diabetes control, having HbA1c levels $< 7\%$. Sample characteristics are described in Table 1.

Table 1. *Baseline characteristics of the participants (N = 232)*

Diabetic patients (N = 232)	
Age, years	58.19(6.32)
Gender_Male (n, %)	123(53%)
Education, years	10.09(2.49)
Marital status (n, %)	
Married	212(91.4%)

Diabetic patients (N = 232)	
Single	5(2.2%)
Widowed/Divorced (n, %)	15(6.5%)
Perceived economic status (n, %)	
Poor	33(14.2%)
Moderate	182(78.4%)
Good	17(7.3%)
Treatment (n, %)	
Insulin	52(22.4%)
Oral medication	169(72.8%)
Nothing	11(4.7%)
Diabetes control, HbA1c	7.37(1.01)
Diabetes control_Good (HbA1c < 7%) (n, %)	108(46.6%)
Duration of diabetes, years	7.52(3.85%)
Comorbidity (n, %)	
No/unknown	91(39.2%)
Hypertension/Heart diseases	67(28.9%)
Dyslipidemia	32(13.8%)
Liver disease	6(2.6%)
Other chronic disease	9(3.9%)
Their combination	27(11.6%)
Microvascular complications (n, %)	63(27.2%)
Diabetes-related knowledge	15.40(3.56)
Climate	5.93(.99)
Autonomous motivation index	1.25(1.23)
Perceived competence	5.65(1.16)
Subjective well being	21.74(4.62)

Note: Values are mean±SD, unless indicated otherwise.

The majority of respondents (60.8%) reported having at least one additional diagnosed chronic illness, with hypertension being the most common condition.

Psychological predictors of glycemic control

The Pearson correlation values of assessed variables are presented in Table 2.

Table 2. *Correlation between glycemic control and the assessed variables*

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Age	1								
2. Education_years	-.244**	1							
3. Diabetes_duration_years	.156*	.102	1						
4. Diabetes related knowledge	-.075	.369**	.124	1					
5. Climate	-.048	.047	-.087	.035	1				
6. Perceived competence	.025	-.032	-.140*	.058	.337**	1			
7. Autonomous motivation index	.055	.128	.070	.233**	-.121	.204**	1		
8. Subjective wellbeing	.019	.222**	.050	.114	.102	.169**	.158*	1	
9. Glycemic control (HbA1c)	-.001	-.139*	-.005	-.098	-.137*	-.274**	-.238**	-.494**	1

Note: * $p < .05$. ** $p < .01$.; categorical variables were not introduced in the correlation matrix

Hierarchical multiple regression was carried out to determine the effect of demographic, clinical and psychological variables on glycemic control in type 2 diabetes patients (HbA1c) (see Table 3).

Table 3. *Multivariate linear regression models with glycemic control as dependent variable*

	Model 1			Model 2			Model 3			Model 4		
	B	SEB	β	B	SEB	β	B	SEB	β	B	SEB	β
Age	-.037	.029	-.084	-.037	.026	-.084	-.024	.025	-.055	-.011	.023	-.024
Gender_male (dummy variable)	-.040	.023	-.108	-.019	.021	-.051	-.027	.021	-.073	-.012	.019	-.034
Education	-.064	.031	-.135*	-.051	.029	-.107	-.054	.028	-.114	-.023	.026	-.048
Marital status_married (dummy variable)	.056	.041	.084	.042	.037	.064	.026	.036	.039	.020	.033	.031
Perceived economic status_good (dummy variable)	-.205	.045	-.288**	-.137	.041	-.193**	-.118	.040	.166**	-.107	.036	.151**
Diabetes duration				-.035	.015	-.148*	-.038	.014	.160**	-.030	.013	-.129*
Diabetes treatment_ insulin (dummy variable)				.055	.026	.123*	.054	.025	.121*	.059	.022	.132**
Comorbid disease_ Hypertension/ Heart diseases (dummy variable)				.073	.025	.178**	.075	.024	.183**	.062	.022	.151**
Comorbid disease_Liver disease (dummy variable)				.042	.067	.036	.058	.064	.050	.093	.059	.080
Comorbid disease_ Dyslipidemia (dummy variable)				.081	.032	.150**	.088	.031	.163**	.085	.029	.158**

MOTIVATION PROFILE AND WELLBEING IN TRANSYLVANIAN HUNGARIANS WITH TYPE 2 DIABETES

	Model 1			Model 2			Model 3			Model 4		
	B	SEB	β	B	SEB	β	B	SEB	β	B	SEB	β
Comorbid disease_Other chronic disease (dummy variable)				.070	.057	.073	.103	.055	.107	.117	.050	.122*
Comorbid disease_Their combination (dummy variable)				.164	.037	.283**	.160	.035	.277**	.135	.032	.234**
Vascular complications (dummy variable)				.131	.026	.315**	.121	.025	.291**	.100	.023	.239**
Diabetes related knowledge				-.012	.024	-.031	.012	.024	.031	.013	.022	.034
Climate							-.021	.050	-.025	-.005	.046	-.006
Perceived competence							-.152	.042	-.212**	-.123	.039	-.171**
Autonomous motivation index							-.021	.009	-.139*	-.017	.008	-.114*
Subjective wellbeing										-.125	.019	-.341**
adj R ²	.098**			.310**			.377**			.478**		
F(df)	6.028(5,226)**			8.403(14,217)**			9.228(17,214)**			12.757(18,213)**		
ΔR^2	-			.234**			.071**			.096**		

Note: * $p < .05$. ** $p < .01$.; categorical variables were introduced in the model as dummy variables; dependent variable: glycemic control (HbA1c)

The hierarchical multiple regression analysis resulted in a statistically significant model, the adjusted R² indicates that a small, 9.8%, percent of the variation in glycemic control could be explained by demographic variables. The model revealed that education and good economic status are negative significant predictors, *participants with a higher level of education and good economic status show better glycemic control.*

Clinical factors and diabetes variables introduced in the second phase of our analysis also contributed to a statistically significant model. Diabetes related variables were found to explain an additional 23.4% of the variation in glycemic control. Adjusted R^2 revealed that 31% of the variance in the glycemic control could be explained by the model, but education lost its predictive power. Results show that several illness characteristics and having comorbidities have predictive power over glycemic control. Diabetes duration, insulin treatment, hypertension and heart diseases, dyslipidemia and the combination of comorbid diseases as well as vascular complications are all statistically significant predictors. Other measured variables did not contribute to the multiple regression model. Results show that illness duration has a significant negative weight, indicating that *participants with longer illness duration* have lower levels of HbA1c and overall *better glycemic control*. This unexpected result is discussed in conclusions. Positive prediction power was found for the other significant clinical variables. *Comorbidities are associated with higher HbA1c percentage, poor glycemic control*. Our analysis indicates that *diabetes-related knowledge has no statistically significant predictive effect on glycemic control*.

Further results revealed that motivational variables have an increased predictive power on our dependent variable. Adjusted R^2 indicated that 37.7% of the variance in glycemic control could be explained by the model. Perceived competence and autonomous motivation were found to be statistically significant predictors. Data revealed that although climate variables explain an additional 7.1% of variation in glycemic control, this motivational factor has weak explanatory power. *Perceived competence and autonomous motivation* both present a significant negative weight, indicating that *participants with higher motivational factors* have lower HbA1c levels, *better glycemic control*.

Finally, the final model with the wellbeing factor included proved to be statistically significant, although the explanatory power is weak. Wellbeing explained an additional 9.6% of the variation in glycemic control; adjusted R^2 indicates that 47.8 % of the variance could be explained by the overall model. The wellbeing variable has a negative weight, suggesting that *participants with better mental wellbeing* have a more optimal glycemic control.

The mediating role of subjective wellbeing between SDT components and glycemic control

In the first mediation model we tested whether wellbeing (ME) mediates the relationship between autonomous motivation (PV) and glycemic control (DV). First, the predictive link between autonomous motivation (PV) and glycemic control (DV) was tested, omitting the mediator. We found that the

total effect is significant, autonomous motivation (PV) significantly predicts glycemic control (DV) ($F(1,230) = 13.84, p < .001, R^2 = .057, b = -.196, t(230) = -3.721, p < .001$). Next, we found that autonomous motivation (PV) significantly predicts wellbeing (ME) ($F(1,230) = 5.92, p = .016, R^2 = .025, b = .59, t(230) = 2.43, p = .016$). The predictor and mediator together significantly predict glycemic control ($F(1,230) = 42.44, p < .001, R^2 = .270$). Regression between wellbeing (ME) and glycemic control (DV) was found to be significant, while controlling for autonomous motivation ($b = -.103, t(229) = -8.189, p < .001$). Finally, we found a significant predictive power of autonomous motivation (PV) upon glycemic control (DV) while controlling for the mediator ($b = -.135, t(229) = -2.870, p = .005$). The indirect effect of autonomous motivation on glycemic control was significant (Effect = $-.06, 95\%$ C.I. $(-.112, -.015)$). The results confirmed that wellbeing partially mediates the effects of autonomous motivation on glycemic control.

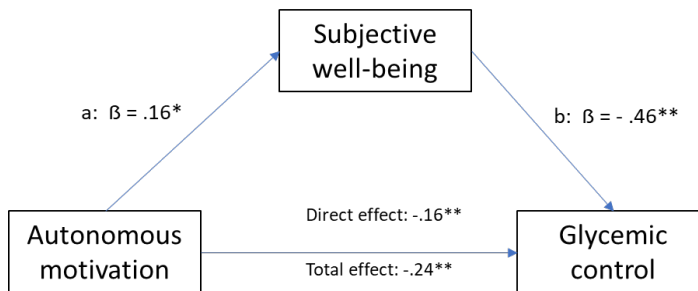


Figure 1. *Mediation model*

Notes. Betas are standardized effect sizes * $p \leq .01$; ** $p \leq .001$

Discussion and Conclusion

Type 2 diabetes is a chronic disease which requires proper disease management, reflected in good glycemic control. Glycemic control is associated with several illness-related factors like diabetes duration, insulin treatment, comorbidities, vascular complications, but also with psychological factors (e.g. motivational components, wellbeing) and demographic variables.

Based on a multivariate linear regression analysis we can conclude that several of the aforementioned factors have good predictive value and are able to explain variations in glycemic control.

When analyzing the role of demographic variables in glycemic control, our results show that good economic status and higher education level predicts a better glycemic control. Age, gender or marital status presents no predictive value for this variable. This result is partially consistent with studies researching the predictive value of SES, race and gender on glycemic control (Assari et al., 2017; Rahman et al., 2020). Research completed in a developing country setting where socioeconomic status (SES) is associated with inequality in both prevalence and control of diabetes suggests that low SES predicts poor glycemic control through health-related behaviors, comorbid conditions, essential health service-related practices (Rahman et al., 2020). In another study, SES-variables show no predictive value, economic status is considered to be predictive for glycemic control when race by gender interaction is included (Assari et al., 2017). Although these studies suggest that gender might have a role in explaining the variance in glycemic control, this variable is mainly a covariate which has no significant independent predictive effect, as presented in our results.

Our data suggests that higher level of education predicts better glycemic control. Previous studies targeted at this demographic factor are inconsistent, and tend to variate depending on the socio-cultural characteristics of participants (Al-Rasheedi, 2014; Gebermariam et al., 2020). This leads us to presume that although higher education may predict better glycemic control in the region of Transylvania, Romania, this link may vary across socio-cultural contexts and therefore should be considered in future research related to glycemic control.

Illness-related clinical factors and comorbidities are predictive for 31% of variations in glycemic control. This effect is stronger for vascular complications and the combination of diseases, with these factors predicting a poorer glycemic control. Higher illness duration, however, leads to a more optimal glycemic control.

Data presenting the effects of higher illness duration on glycemic control is contradictory (Gebermariam et al., 2020; Saghir et al., 2019; Shita & Iyasu, 2022). The findings suggest that there is a significant difference between institutional healthcare and health management behavior of diabetes patients in different regions, leading to distinctive effects on glycemic control and prevention of complications.

While results regarding clinical factors of illness and comorbidities are overall supported by the current literature (Rahman et al., 2020; Shita & Iyasu, 2022), vascular complications and combinations of diseases are not specifically predictive on glycemic control.

Our results indicate that diabetes knowledge has no significant predictive effect for glycemic control. Although researchers emphasize the positive association between proper diabetes education and the patients' better glycemic control (McPerson et al., 2008; Ozcelik et al., 2010), in other studies diabetes knowledge is not a significant predictor for glycemic control (Adarmouch et al., 2017; Dube et al., 2015). Osborn et al. (2010) posit that diabetes knowledge is an independent, direct predictor of diabetes self-care and is related to glycemic control through self-care. This result might explain our data which indicates that diabetes knowledge has no direct linear influence on the outcomes in glycemic control. These findings suggest that there is a need for further research targeted on mediator and moderator factors influencing the role of diabetes knowledge in glycemic control.

In a more recent meta-analytic study Marciano et al., (2019) state that glycemic control is best predicted by performance-based and self-report health literacy. Diabetes knowledge is not a direct predictor of glycemic control. This reveals the need for studies which also consider the role of health literacy and its relationship to specific diabetes knowledge.

Analysis conducted on motivational aspects of SDT reveals those participants with a higher level of perceived competence and autonomous motivation, present better glycemic control. The result is in line with previous findings on patient autonomy and health (Ng et al., 2012; Williams et al., 2004; Williams et al., 2005; Yun et al., 2020), and suggests that competence and autonomy are components less anchored in the socio-cultural context of participants. Results also emphasize the importance of training and support groups focused on developing and maintaining the autonomous motivation of patients.

The wellbeing variable has a weak, but significant direct effect on glycemic control, thus better mental health is predictive for a more optimal glycemic control. Although the effect is weak, our result is consistent with previous studies, specifically that overall wellbeing and positive psychological constructs are correlated with better glucose control (Massey et al., 2010; Papanas et al., 2017). Additional analysis leads to the conclusion that subjective wellbeing has a partial mediating role on the relationship between autonomous motivation and glycemic control. Although the psychosocial factors related to health outcomes in patients with diabetes have been studied exhaustively, we are not aware of articles discussing the possible mediator role of wellbeing variables. This could be an important aspect to consider and could further allow a better matching of patients to compensatory interventions.

This study proposes several important conclusions. First, perceived competence and autonomous motivation are important in reaching an optimal

glycemic control, but the effect of motivation is partially mediated by wellbeing components. Second, illness related characteristics like vascular complications, comorbidities and illness duration prove to be essential predictors of glycemic control. Third, illness duration seems to have a specific effect on glycemic control for patients living in Transylvania, Romania. Although diabetes-related knowledge (expected to increase over time) does not predict better glycemic control, results suggest that in time patients acquire experience in managing type 2 diabetes and those with longer illness duration have a more optimal glycemic control. Future research should address the interaction between demographic characteristics and illness duration in predicting diabetes management.

Limitations

The design of the study is cross-sectional, which limits our ability to clarify causal relationships between targeted variables. Further research should examine this topic with an experimental design.

The HbA1c extracted from medical records was collected from the last three months prior to the recruitment of the participants. Despite the fact that HbA1c is the standard measure for the diagnosis and monitoring of diabetes, HbA1c derived from multiple time points could better reflect the glycemic control than a single reading. The metabolic outcomes of diabetic patients could be improved by adequate motivation training and increased wellbeing, hence future research should address this subject using an experimental methodology in longitudinal studies.

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The relationship between theory of mind and children's moral judgment: A scoping review

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ABSTRACT. Theory of mind is the ability that allows us to decipher human behavior by understanding the desires, beliefs, intentions, and motivations of others and our own. It also permits us to predict others' behavior and model our own in order to act morally toward others. Moral judgment (the ability to appraise whether an intention or the outcome of an action is good or bad) involves mental state understanding, especially when detecting other's intentions. Because the relationship between theory of mind and moral judgment in early and middle childhood is far from being clearly understood, we conducted a scoping review that allowed us to advance valuable avenues for future research. Of the 34 papers initially identified in five databases (Google Scholar, Web of Science, Scopus, PsycInfo, and ResearchGate), 20 studies were eligible and analyzed concerning their main results and the assessments used for both theory of mind and moral judgment. Most studies reported a direct relationship (one study identifying even bidirectional links) between the two variables of interest. A discussion regarding the implications and future directions is put forward to advance research in children's understanding of their worlds (internal and external) in a socio-moral way.

Keywords: theory of mind, moral judgment, children, autism, scoping review

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Introduction

Very early on, as they enter preschool, children are faced with the complex nature of social interactions and have plenty of opportunities to witness moral transgressions (e.g., hitting, exclusion from play, unwillingness to share, rule-breaking, and teasing). In order to make accurate moral judgments, representing evaluations if someone's intentions or their actions and outcomes are wrong or right) and to flexibly respond to transgressions, they need to correctly assess complex situational information. Children must consider both transgressor's and victim's mental states, the outcomes, and even the level of negligence behind the action (Margoni & Surian, 2020; Nobes et al., 2009).

Recent research offers a more specific and differentiated theory of morality than Kohlberg's global stage model (1969), highlighting the importance of investigating the socio-cognitive components of moral behavior. This model proposes that moral development emerges from a self-oriented, pre-moral level (stages 1 and 2), and advances through a group-conventional level (stages 3 and 4) until it reaches a justice level (stages 5 and 6). A theory that complements Kohlberg's model is the Social Domain Theory (Nucci, 2001; Smetana, 2006; Turiel, 2006) which proposes that morality consists of three domains of social knowledge (moral, societal, and psychological) and is built out of social interactions. Empirical research has demonstrated that these three types of knowledge coexist within individuals and are essential tools for evaluating straightforward and complex situations (Killen & Rutland, 2011; Smetana, 2011; Turiel, 2006). Thus, the evaluation and interpretation of social events involve three types of reasoning: moral reasoning (physical and psychological harm; issues of fairness, equality, and justice), societal reasoning (concerns about conventions and social institutions, group norms and group functioning, traditions, and cultural rituals), and psychological reasoning (concerns with identity and autonomy, personal goals and individual prerogatives; Nucci, 2001).

The current review focuses only on the first type (moral reasoning) and its relationship with theory of mind (ToM; the ability to infer other people's desires, beliefs, and intentions; Wellman & Liu, 2004) since recent research has highlighted the importance of mental states understanding in moral cognition (Chakroff & Young, 2015; Young & Tsoi, 2013). The aim of this scoping review is to highlight the complex nature of the relationship between moral judgment and ToM and to propose future research directions that could fill the existing gaps in the literature.

Children's moral judgment progressively improves from age 3 onward (for a review, see Smetana et al., 2018), as children undergo rapid cognitive development. The ability to coordinate acts, intentions, and outcomes is

sustained by cognitive gains in children's information-processing skills that are visible between 3 and 7 years of age (Zelazo et al., 1996). After the age of 7, a more advanced ToM form develops, interpretive theory of mind (iToM, understanding that people's beliefs represent interpretation of information; Carpendale & Chandler, 1996; Lalonde & Chandler, 2002) that allows children to have a more profound social understanding. A child with iToM should be able to recognize both the RECIPIENT (the one needing help) and the AGENT (the one in a position of offering help) interpret the context from their individual perspective, and there might be a conflict between these two points of view. This complex understanding has great implications for moral judgment but the link between iToM and children's moral judgment needs further investigation (Harari & Weinstock, 2021).

Two essential components of moral reasoning are the ability to distinguish intentional from accidental actions and the ability to differentiate between positively and negatively valenced outcomes. A typical moral judgment task requires children to evaluate the acceptability / wrongness of an act ("When [AGENT] offered [RECIPIENT] the box, was [AGENT] doing a good thing, a bad thing, or just okay?") performed with intent or by accident and then assign an amount of punishment or reward to account for that action ("Should [AGENT] get in a lot of trouble, a little trouble, or no trouble?" Ochoa et al., 2022a). Punishment judgment refers to the act of imposing consequences on individuals who cause harm or deviate from societal norms (Cushman, 2008). Children expect wrongdoers to be penalized (Kenward & Osth, 2012) and they punish selfish peers both when they are directly affected and when another has suffered injustice (Vaish et al., 2011). When children's moral judgment focuses mostly on intentions, their punishment judgments also become substantially more intent-based (Nobes et al., 2016).

In order to make accurate moral judgments, children need to be able to differentiate between *intentional harm* (when someone causes a negative outcome having a negative intention), *accidental harm* (when someone causes a negative outcome having a neutral or positive intention), and *attempted harm* (when someone causes nothing even though had the intention to cause harm). In order to be successful at this task, children need to manage to inhibit the outcome information and to focus primarily on the intention information. During preschool, children's moral judgments develop at an accelerated pace, with an important shift occurring from outcome-based moral judgment to intent-based moral judgment (Zelazo et al., 1996; see Margoni & Surian, 2016b for a review). In outcome-based moral judgments, children's evaluations rely on the consequences of an action, such as the victim's emotional distress cues in the case of harmful actions. Conversely, in intent-based moral judgments,

evaluations rely on the agent's mental states, which allows for distinguishing between intentional and accidental actions, and also between types of motives for performing an action (having good or bad intentions). For example, 3-year-olds tend to condemn the prosocial agent who accidentally performed an action that resulted in a negative outcome, suggesting that they focus more on the consequences of that act, rather than on the absence of a bad intention (Cushman et al., 2013; Margoni & Surian, 2017).

According to the dual-process model (Cushman, 2008, 2013; Cushman et al., 2013) act evaluations are mostly generated by the intent-based process (relying especially on mental states information), while the punishment evaluations are generated by both intent-based and outcome-based processes (relying on both mental states information and other consequences factors). Thus, these two types of moral evaluations (act and punishment judgments) are supported by two distinct underlying processes, rather than a developmental replacement of the outcome-based evaluations by the intent-based evaluations. When intentions and outcomes are in direct opposition to one another (good intentions - negative outcomes) children within this age range often struggle to coordinate such competing information (D'Esterre et al., 2019). This difficulty could stem from the fact that the outcome of an action - unlike the intentions - is immediately visible and does not need to be inferred. Supporting this hypothesis are results showing that young children are able to take intent into account when the agent's mental states are explicitly presented (Baird & Astington, 2004; Nelson, 1980). In addition, children with a higher ToM ability evaluate the moral quality of an action more accurately (if the actor has a good or a bad intention) (Dunn et al., 2000; Fu et al., 2014; Killen et al., 2011). Developmental changes in ToM are associated with intent-based moral judgment (Killen et al., 2011). These results indirectly suggest that ToM could be an important developmental socio-cognitive mechanism that supports the shift from outcome-to-intent in young children's sociomoral evaluations.

ToM skills involve progressive abilities that enable inference of other's mental states at different levels of recursive thinking (*first-order ToM*, Lisa thinks X; *second-order ToM*, Lisa thinks Anna thinks X), helping to understand the complexity of human social interactions (Rakoczy, 2022). In addition, a more complex ToM understanding, also called "***morally-relevant***" ***ToM*** (MoToM; Killen et al., 2011) enables children to intersect their mental states understanding and their moral reasoning in complex social and moral contexts. In the seminal study of Killen et al. (2011), a MoToM task was developed to see if and when children detect the intentions of an accidental transgressor (a child wanting to help the teacher clean the classroom throws away a classmate's bag, thinking it

contained garbage, when instead it contained a highly desirable item - a classmate's cupcake). The participants are asked (1) a contents false belief question ("What did the teacher's helper think was in the bag?"); (2) an intention question ("When the teacher's helper threw out the bag, did he/she think he/she was doing something that was all right or not all right?"); (3) a justification question ("Why?"); (4) an act evaluation question ("When the teacher's helper threw out the bag, do you think he/she was doing something that was all right or not all right?"; and (5) a justifications question ("Why?"). The next three questions referred to the actions of the victim: (6) a location false belief question ("Now the classmate wants to eat the cupcake that they brought in from home. Where will he/she look for his/her cupcake?"); (7) attributions of the emotional state of the victim ("How will the classmate feel about losing his cupcake?"); and (8) attributions of the victim emotion towards the accidental transgressor ("How will the classmate feel about the teacher's helper?"). The authors found that only the children who passed the false belief tasks in this morally-relevant scenario were able to dismiss the accidental transgressor from the negative outcome and assign less punishment than children who did not demonstrate a false belief understanding in this complex moral setting.

Subsequent research showed that children's MoToM serves as a strong predictor of their moral judgments (D'Esterre et al., 2019; Fu et al., 2014; Li et al., 2017). Moreover, MoToM was a better predictor for moral judgment than both age and classical ToM (false belief understanding; D'Esterre et al., 2019). A recent study (Glidden et al., 2021) found that MoToM competence also mediated between children's group membership and their moral judgments (intention evaluation and social exclusion decision). Nonetheless, even though research has shown that ToM informs and constrains moral judgment (Killen et al., 2011; Wainryb & Brehl, 2006), there are studies that found ToM not always required when children judged whether causing harm to another person was wrong (Zelazo et al., 1996) or when evaluating moral issues in different contexts (Smetana, Jambon, et al., 2012). Given these mixed results, the potential relationship between ToM and children's moral judgment requires deeper and further theoretical and methodological consideration.

Moreover, examining moral judgment in *atypical development* is another direction worth pursuing and possibly capable of elucidating this relationship. Of particular interest is autism (Autism Spectrum Disorder - ASD; APA, 2013), a developmental disability characterized by communication difficulties and severe social impairment. Since ToM is essential for moral judgment, and because ToM is impaired in autism, the investigation of the relationship between moral judgment and ToM in this atypical population could

bring valuable insights into children's moral judgments. The difficulties that define autism are often linked with difficulties in mental state understanding (Baron-Cohen et al., 2013; Peterson et al., 2012; Surian & Leslie 1999). Studies on moral reasoning in autism pertain to two lines of investigations (for a review see Margoni & Surian, 2016a). The first line examined if these children can differentiate between moral and conventional norms and found just a little delay in acquiring this knowledge as compared to typically developed (TD) children (Rogers et al. 2006; Shulman et al. 2012; Zalla et al. 2011), even though ASD children rely more on external factors (emotional cues; Margoni & Surian, 2016a) in their judgments. The second line investigated children's ability to decipher mental states before making a moral evaluation and the results are mixed and not straightforward (Buon et al. 2013; Grant et al. 2005; Salvano-Pardieu et al. 2016; Steele et al. 2003), ranging from completely relying on outcomes (Grant et al., 2005) to an immature intent-based moral judgment (Hamilton, 2009). Thus, further research with ASD children could bring more insight about the role of ToM in children's moral judgments.

Method

The current scoping review aimed to 'map' the emerging relevant literature at the intersection of the moral and the socio-cognitive domains and identify research gaps concerning the relationship between ToM and children's moral judgment. We started by using the five stages of the methodological framework for scoping reviews developed by Arksey and O'Malley (2005) and also followed the scoping review guidelines proposed by Tricco et al. (2018). First, we formulated the research question, and then we employed a search strategy that enabled us to identify and select relevant literature. Second, we charted and summarized the data and finally, reported the results and critically discussed them suggesting future research directions.

The computer-based search was conducted on high-impact databases in the fields of psychology (PsychInfo), education (ERIC), and interdisciplinary databases (Google Scholar, Web of Science, Science Direct, Scopus, ERIH PLUS) in order to identify relevant scientific papers. The keywords that we used were: theory of mind, false belief understanding (FB), mentalizing, first-order ToM, second-order ToM, moral judgment, moral evaluation, wrongness evaluation, act acceptability evaluation, and punishment attribution. The Boolean operator AND was used in addition to quotes for compound terms.

Inclusion-exclusion criteria

According to our inclusion-exclusion criteria (see Table 1), we excluded studies in which theory of mind and/or moral judgment was measured only by psychophysiological/imaging methods (such as fMRI and other brain scans), and those using indirect measures of these variables. Also, we selected only papers written in English and we limited them to the ones published in the last 25 years because of the methodological refinements brought to the moral judgment tasks in this interval).

Table 1. *Selection Stages of Inclusion and Exclusion Criteria*

Selection Stages	Inclusion Criteria	Exclusion Criteria
Stage 1 - papers retrieved based on titles and abstracts (a single researcher performed this stage) and stored in Sciwheel®	Papers investigating the relationship between ToM and moral judgment (MJ)	Addressing other constructs in moral reasoning (i.e., societal reasoning and psychological reasoning).
	Papers published in the last 25 years	
	Empirical studies published in English	Reviews, theoretical studies, and book chapters.
	The papers are available in full-text	The full text was not available or was not published in scientific journals
Stage 2 - papers selected based on the reading of the full texts (two independent researchers performed this stage) organized in a shared GoogleDrive®	Preschoolers and school-aged children with typical and atypical development	College students and adults
	Including ToM, MoToM, and prototypical moral judgment tasks.	Measuring other constructs pertaining to moral judgment (blame, "side-effect" effect).

Data collection and analysis procedure

Concerning data collection, for uniform access among researchers and for systematizing the general information, the Sciwheel® reference management program was used (Stage 1). GoogleDrive® was next used for storing and

organizing the relevant papers suitable for the descriptive analysis (Stage 2). As for the analysis procedure, the co-authors noted in a spreadsheet when and who performed the analysis, and the papers were subdivided into terms of theoretical concepts, aims, and objectives of the study, hypotheses, design, used measurements for the variables of interest, results, and discussion of results. The author with more expertise in the field mediated disagreements at each stage.

After identifying, evaluating, and eliminating the duplicates according to the inclusion-exclusion criteria, 19 papers were eligible for further analysis. The summary of the results of the included studies was organized into three sections. Therefore, the first section presents a brief description of the analyzed papers. The second section portrays a general overview of the main findings. The third section portrays the ToM-MJ relationship. Finally, we highlight the limitations, implications, and future directions in studying children's moral judgment.

Results

The search was conducted from March to April 2023 and a total of 78 papers were initially identified in the databases. After using filters set by date, age range, and after reviewing the research aims of the found studies, 44 studies were excluded from the initial sample, thus remaining 34 papers for full-text reading. Eighteen of these papers met all the inclusion criteria, the others ($n = 16$) being excluded for the next considerations: 1) not measuring ToM ($n = 4$) explicitly; 2) measuring other forms of moral reasoning (societal and psychological; $n = 5$); 3) investigating the ToM-moral judgment relationship in TD adults ($n = 4$) and 4) ASD adults ($n = 3$).

Table 2 presents a summary of the 20 studies investigating the relationship between ToM and moral judgment in TD and ASD children. The first study, dating from 2000, was conducted in the United Kingdom, and the more recent one is from Romania and is currently under review. The majority of the studies were conducted by authors located in the United States of America ($n = 10$), followed by China ($n = 2$), Spain ($n = 2$) the United Kingdom ($n = 1$), Italy ($n = 1$), Indonesia ($n = 1$), Brazil ($n = 1$), Israel ($n = 1$), Romania ($n = 1$). The participants were preschoolers and school-aged TD and ASD children. Some of the studies also included adult samples for comparison reasons. Age ranged from 2.5 to 15 years.

Concerning instruments for **ToM assessment**, the majority of studies used the classical *false belief task* (first-order ToM; $n = 10$), the *second-order ToM task* ($n = 3$), an *interpretive ToM task* ($n = 1$), a *deception task* ($n = 1$), a *strange stories* task (Happé, 1994; cognitive and affective ToM; $n = 1$). For the

moral judgment assessment, the tools were more diverse, such as: three studies used *motive-based moral stories* (identifying the different motives behind identical actions; Baird & Astington, 2004); another three studies used *moral transgressions stories* (pushing someone off the swing; Smetana, 2006); one study used a *moral judgment of unintentional and intentional false claims* measure. The authors also employed *interview-based tasks* (the Social events interview, $n = 2$; The Morally-relevant belief vignettes, $n = 2$; the Moral interview, $n = 1$; Moral dilemmas, $n = 1$) (see Table 2 for more details). An interesting observation was that the studies reviewed used the morally-relevant ToM task sometimes for measuring children's ToM ($n = 3$) and sometimes for measuring children's moral judgment ($n = 6$).

The majority of the studies were quantitative, and cross-sectional, whereas two were longitudinal studies (Seucan et al., under review; Smetana et al., 2012). The analyses mainly consisted of correlational and intra- and inter-group inferential studies, using variables related to age, gender, act evaluation, punishment attribution, and scores obtained in the ToM tasks (both overall scores and scores obtained in subtasks: contents false belief, location false belief, second-order ToM, etc.). Five studies investigated the relationship between ToM and moral judgment with other variables of various constructs, such as language and IQ (predominantly used as control measures); empathy, emotion understanding, deception detection, friendship, and group membership. Moreover, one study (Glidden et al., 2021) investigated if ToM could be a mediator between children's group biases and their moral judgment (intention evaluation and peer exclusion decision).

Main findings

General overview

The majority of the studies reviewed in the current study identified a statistically significant association between ToM and children's moral judgment, even after controlling for other potentially relevant constructs, such as age, inhibitory control, verbal intelligence. There was only one study (Loureiro & Souza, 2013) to report a non-significant association between ToM-moral judgment. However, the study had only 24 TD children, potentially providing insufficient power to detect a relation. All the other studies reported a significant ToM-MJ relationship, but nonetheless, the direction of the relationship varied. For example, even though the majority of the studies found a positive association between the two variables of interest, there was one study (Hao & Liu, 2016)

that found that ToM and deontological moral judgments (moral rules should be abided by regardless of the consequences; Kant, 1959) were negatively correlated for children (8- to 10-year-olds), adolescents (13- to 15-year-olds), and older adults (60- to 70-year-olds) but positively correlated for younger adults (19- to 24-years old).

Another study (Glidden et al., 2021), found an indirect relationship between ToM and moral judgment, such that ToM mediated between children's group membership and their intent evaluations and the decision to exclude another (ingroup vs. outgroup). In this study, ToM understanding was investigated using a MoToM task and MJ was examined using an attribution of intention question. The authors found that when children had to attribute intention in an advantageous condition, morally-relevant ToM mediated the relation between group membership and moral judgment (see Table 2 for the summary of the papers). The single study measuring interpretive ToM (Harari & Weinstock, 2021), found that this particular ToM form, and not ToM false belief ToM understanding, enabled children to take the empathic perspective in prosocial moral conflicts and make more accurate evaluations.

Concerning the developmental milestones, after 3 ½ years of age, children's ToM (first-order ToM, contents false belief understanding, location false belief understanding) develops and helps them appropriately evaluate prototypic transgressions (Ball et al., 2017; Dunn et al., 2000; Fu et al., 2014). Later, between 4 and 6 years of age, first-order ToM contributes more to children's moral judgment in intentional transgressions and less in accidental transgressions (Kuntoro et al., 2018). Ochoa et al. (2022a) showed that 5-year-olds with higher ToM rate agents with false beliefs as more positively intentioned in good intent trials (even though the outcome was bad) than in bad intent trials (even though the outcome was good). Nonetheless, 4-year-olds with higher ToM did not manage to integrate their false belief understanding with their moral judgments any better than same-age children with low FB understanding, suggesting that before the age of 5, children cannot integrate beliefs that do not correspond to reality in their moral judgments even though they have a false belief understanding. Beginning with 6-7 years of age, when second-order ToM develops, children make accurate evaluations of the accidental transgressor's intention (Fu et al., 2014). Moreover, once children integrate their false belief understanding in a morally-relevant context (MoToM), this understanding predicts their moral judgment above and beyond age and false belief understanding (D'Esterre et al., 2019; Killen et al., 2011).

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Table 2. Summary of Papers Included in the Scoping Review

Paper	Sample's origin and size	Participants	Aims of the study	ToM measure(s)	MJ measure(s)	Relationship ToM-MJ
Baird and Astington (2004)	USA (N = 42)	4-, 5- and 7-year-olds typically developed and with a behavior disorder	investigate children's ability to consider mental states in evaluating the moral quality of others' actions	-first-order false-belief tasks (Perner et al., 1987) -second-order false-belief tasks (Homer & Astington, 2001)	-motives-based moral reasoning task (moral stories without specifying the outcomes of the actions)	-children's ToM was significantly correlated with the act evaluation and the punishment attribution both for the typically developed and those with a behavior disorder
Ball et al. (2017)	USA (N = 108; 56 girls)	3 ½ years olds	investigate associations among preschoolers' empathy, false belief understanding, and moral judgments	- unexpected contents false belief task -change of location false belief task (Wellman & Liu, 2004)	-Social events interview (Smetana, 1985) - moral stories without specifying the consequences of transgressions	-greater ToM associated with more mature moral judgments; -ToM associated with judgments of physical harm but not psychological harm; -significant interaction between ToM and empathy predicted judgments about psychological harm -preschoolers with low ToM did not distinguish between moral and conventional issues in judgments of deserved punishment
D'Esterre et al. (2019)	USA (N = 122; 62 girls)	4- to 10-year olds	investigating ToM's role in children's ability to differentiate between intentional and unintentional false claims regarding resources.	- a content false belief task (Gopnik & Astington, 1988). - a morally relevant false belief ToM (MoToM; Killen et al., 2011)	-a moral judgment of unintentional -intentional false claims measure (developed by the authors)	- ToM predicted more favorable evaluations of the unintentional transgressor; -MoToM predicted children's responses for all of the assessments above and beyond age and false belief understanding.
Dunn et al. (2000)	UK (N = 128; 63 girls)	3- to 4-year olds	investigating relations between children's views on the permissibility of transgressions involving friends and justification for such views, and their ToM	-seven theory of mind tasks (involved predicting, explaining or recalling a false belief; Cutting & Dunn, 1999) --a deception task (Sodian & Frith, 1992)	-Moral interview (Slomkowski & Killen, 1992)	-children's ToM was positively correlated with act permissibility and moral justification
Fadda et al. (2016)	Italy (n = 30 TD children and n = 30 ASD children; all boys)	10- to 12-year-olds	investigating whether ToM might foster children's autonomous MJ achievement.	-a second-order ToM task (Perner & Wimmer, 1985)	-MJ task (Piaget, 1932)	-children with ASD lacking ToM abilities judged guilty the protagonists of the two versions of morally appropriate behavior and focused more on outcomes than intentions
Fu et al. (2014)	China (N = 79; 39 girls)	4- to 7-year olds	investigating the interrelationships between children's moral judgments	-content false belief task; (Wellman & Liu, 2004)	-MoToM task (Killen et al., 2011) -The prototypic	-second-order ToM and MoToM both played an important role in young children's accurate attributions of the accidental

Paper	Sample's origin and size	Participants	Aims of the study	ToM measure(s)	MJ measure(s)	Relationship ToM-MJ
			of accidental and prototypic transgressions and first-order and second-order ToM	-location false belief task (Wimmer & Perner, 1983) -two second-order false belief task (Astington et al., (2002) and Sullivan et al., (1994))	moral transgression story (Smetana et al., 2014)	transgressor's intention. -first-order ToM helps children appropriately evaluate prototypic transgressions
Garcia-Molina et al. (2019)	Spain (N = 60) n = 30 TD; 4 girls n = 30 ASD, 4 girls	7- to 12-year olds	investigating the link between ToM and moral judgment	-first-order ToM (De Villiers & De Villiers, 2012)	MJ task (Molina et al., 2019)	-ASD children had difficulties in moral judgments in a context involving deception; -ASD children based their justifications less on mental states than TD children
Garcia-Molina et al. (2020)	Spain (N = 62) n = 32 TD; 7 girls n = 30 ASD, 5 girls	7- to 12-year olds	investigating the ToM-MJ relationship in TD and ASD children	-4 'Faux Pas' stories of accidental situations (Baron-Cohen et al., 1999)	-4 stories of intentional situations (Garcia-Molina et al., 2016)	-ASD children had difficulties in understanding the moral transgressions when the action directly affected another person and not an object;
Glidden et al. (2021)	USA (N = 120; 64 girls)	4- to 7-year olds	investigating the relationship between ToM, group membership, and MJ.	-MoToM question (false belief evaluation)	-Attribution of Intention (AoI) question (acceptability of intention evaluation)	-MoToM mediated the relations between group membership and attribution of intentions in an morally-relevant advantageous condition, but not when an advantage was a straightforward moral transgression. -MoToM was predictive of person judgments and varied based on ingroup/outgroup status of the target.
Gönültaş et al. (2021)	USA (N = 117; 81 girls)	3- to 8-year olds	investigating whether children consider victim negligence when making judgments and whether children's ToM influences their assessments	-a false-belief contents task (Wellman & Liu, 2004)	-two moral transgression stories (MoToM; Killen et al., 2011; Nobes et al., 2009).	-children with higher ToM were more likely to consider victim's negligence when making moral judgments. -children with higher ToM were more likely to use negligence information in their punishment judgments for the transgressor and victim in both conditions (negligent vs. careful). -children with lower ToM did not differentiate their punishment judgments for the transgressor and victim.
Harari & Weinstock (2020)	Israel (N = 225; 120 girls)	7- to 11-year olds	investigating if iToM would predict better than ToM prosocial moral reasoning	-a iToM task (Lalonde & Chandler, 2002)	-three prosocial moral dilemmas (Eisenberg-Berg & Hand, 1979)	-iToM, but not ToM, predicted empathic and internalized values of prosocial moral reasoning, even when controlling for age, inhibitory control and emotion understanding.
Hao & Liu	China (N =	8- to 10-year olds	investigated whether ToM was	-the strange stories	-the moral dilemmas	ToM and deontological moral judgments were negatively

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Paper	Sample's origin and size	Participants	Aims of the study	ToM measure(s)	MJ measure(s)	Relationship ToM-MJ
(2016)	204; n = 48; 21 girls; n = 45; 26 girls; n = 62; 36 females ; n = 49; 24 females)	13- to 15 year-olds 19- to 24 years 60- to 70 years	consistently positively associated with MJ from middle childhood to late adulthood.	(cognitive and affective ToM; Happé, 1994)	(Hauser et al., 2007)	correlated for children, adolescents, and older adults but positively correlated for younger adults.
Killen et al. (2011)	USA Study 1 (N = 162; 90 girls) Study 2 (N = 46; 25 girls)	3.5-, 5.5- to 7.5- year-olds	investigating children's false belief ToM in a morally relevant context	Study 1 & 2 -contents false belief task -location false belief task (Wellman & Liu, 2004)	Study 1 & 2 -MoToM task (Killen et al., 2011) -prototypical moral transgression task (Smetana, 2006)	Study 1 -children with higher ToM were more likely to attribute good intentions to the accidental transgressor than children who didn't pass the false belief tasks; Study 2 -children with higher ToM were less likely to punish the accidental transgressor than those who didn't pass the false belief tasks.
Kuntoro et al. (2018)	Indonesia (N = 122)	4- to 6-year olds	investigating the contribution of children's ToM in morally relevant situations and moral judgment	-five ToM tasks (diverse desires, diverse beliefs, knowledge access, false beliefs, and, hidden emotions; Wellman & Liu, 2004)	-MoToM (Killen et al., 2011) -a scale of prototypical moral transgressions (Smetana, 2006)	-ToM contributes towards children's moral judgment in intentional moral transgressions but not in accidental transgressions
Lane et al. (2010)	USA (N = 128; 68 girls)	3.5- to 5.5 year-old	longitudinally investigating how ToM and emotion understanding concurrently and prospectively predict children's MJ	-false belief understanding (Bartsch & Wellman, 1989) -appearance-reality emotion understanding (Harris et al., 1986)	-moral judgment task (Eisenberg-Berg & Roth, 1980)	-a more advanced ToM predicted greater use of psychological-needs reasoning; -ToM and emotion understanding jointly predicted moral judgment
Loureiro and Souza (2013)	Brazil (N = 24; 13 girls)	4- to 6-year olds	investigating the relation between ToM and moral judgment (based on intention and based on motive)	-4 ToM tasks (Wellman & Liu, 2004)	-a MJ task based on motive (Baird & Astington, 2004); -a MJ task based on intention (Nelson-Le Gall, 1985)	- correlations between ToM and scores in the moral development tasks were not significant
Ochoa et al. (2022a)	USA Study 1 (N = 64; 28 girls) Study 2 (N = 109; 55 girls; n = 42 adults)	4- to 5-year olds	investigating the influence of false belief understanding on moral judgment Study 1	Study 1 -standard false belief task (Leslie et al., 2005)	Study 1 -Morally-relevant Belief Vignettes (2 stories with true belief and 2 stories with false belief) -standard moral transgression task (Smetana,	Study 1 - 5-year-olds with higher FB rated agents with false beliefs as more positively intentioned in good intent trials (even though the outcome was bad) than in bad intent trials (even though the outcome was good); - 4-year-olds with higher FB did not manage to integrate their false belief understanding with their

Paper	Sample's origin and size	Participants	Aims of the study	ToM measure(s)	MJ measure(s)	Relationship ToM-MJ
			Study 2 - reduced task demands, simplified design; punishment and reward evaluation	Study 2 -Morally-relevant Belief Vignettes Agent belief ("What does [AGENT] think is in the container?")	2006) Study 2 -Morally-relevant Belief Vignettes Agent intention evaluation ("When [AGENT] handed [RECIPIENT] the box, was [AGENT] trying to be nice, mean, or just okay?"); Agent consequence evaluation ("Why should [AGENT] get [assigned consequence]) Assign punishment/reward	moral judgments any better than same age children with low FB understanding. - all had difficulties assigning punishment based on intent. Study 2 -4-year-olds with higher FB made appropriate intent judgments; - children of all ages had difficulties assigning punishment based on intent.
Ochoa et al. (2022b)	USA (N = 61; 24 girls)	5- to 7-year olds	investigating relations between false belief understanding and moral judgments	-Morally-relevant Belief Vignettes Agent belief ("What does [AGENT] think is in the container?")	-Morally-relevant Belief Vignettes Agent intention evaluation ("When [AGENT] handed [RECIPIENT] the box, was [AGENT] trying to be nice, mean, or just okay?")	- 5-year-olds consistently rated agents with false beliefs as better intentioned in a good intent condition (even though the outcome was bad) than in a bad intent condition (even though the outcome was good).
Seucan et al. (under review)	Romani a (N = 92; 43 girls)	3- to 5-year olds	investigating relations between ToM, emotion understanding and moral judgment	-3 ToM tasks (Wellman & Liu, 2004)	- 3 moral stories (Baird & Astington, 2004)	-MJ was associated with ToM and with emotion understanding; -punishment evaluation was predicted only by emotion understanding
Smetana et al. (2012)	USA (N = 70; 37 girls)	2.5- to 4 year-olds	investigating associations between children's ToM and judgments of prototypical moral transgressions	-five ToM tasks (diverse desires, diverse beliefs, false beliefs (both contents and location), and belief-emotion relationships)	-Social rules interview (Smetana & Braeges, 1990)	-early MJ and ToM develop as reciprocal, bidirectional processes: -children who evaluated moral acts as more wrong independent of authority had more mature ToM 6 months later; -judgments of moral transgressions as less permissible at Wave 2 also led to more advanced ToM at Wave 3; -more advanced ToM initially led to evaluations of moral transgressions as less independent of rules and then to judgments of moral transgressions as more independent of rules

Discussing the association between ToM and moral judgment

Act evaluation

Research aims to unravel the role that understanding other minds plays in children's ability to decide if an action with a good or a bad outcome was performed with good or bad intentions. The studies included in the current scoping review found a direct relationship between ToM and moral judgment, yet this relationship differed in terms of ToM type (first-order ToM, second-order ToM, morally-relevant ToM) and in terms of moral transgression type (prototypical standard transgression, morally-relevant transgression). As such, Baird and Astington (2004) found that 5- to 7-year-olds' ability to consider people's intentions to make moral distinctions between identical actions was facilitated by children's false belief understanding. Using the same task, but on a younger sample (3- to-5-year-olds), Seucan et al. (under review) showed that ToM enables such young children to make accurate moral judgments, correctly identifying the intention (good vs. bad) behind identical actions. Building on previous findings (Lane et al., 2010), in their study, alongside ToM, emotion understanding (Pons et al., 2004) was also a predictor of such young children's moral judgments (and even of punishment attributions), indicating that ToM - although necessary in young children's moral judgments - may not be sufficient to enable them.

A somewhat similar result was obtained by Ball et al. (2016) who investigated the association between 3½-year-olds' moral judgments and their ToM and empathy. They found that both ToM and empathy were associated with moral judgment in related but distinct ways, according to the type of harm and related judgment. Children in their study evaluated physical harm acts more negatively than acts of unfairness. Even though they condemned unfairly taking another's resources, preschoolers evaluated inflicting physical harm on another as more serious. Ball et al. (2016) found that higher ToM was associated with children's view of moral transgressions as invariably wrong, independent of authority mandates or rules. In their study, the consequences of the transgressions were not specified, so children needed to infer them before making their judgments.

In addition, higher ToM was associated with more mature judgments about psychological harm, but only for less empathic preschoolers. Therefore, low-empathy preschoolers might be more inclined to apply their mental states understanding to infer psychological harm. Conversely, Ball et al. (2016) found that for preschoolers lower in ToM, higher empathy was associated with more mature moral judgments. This result suggests that children with less advanced

ToM may rely more on affective information such as the perceived distress of the victim when evaluating moral acts (Arsenio & Ford, 1985). Another interesting result was that empathy and moral judgment were not linked in preschool children with higher ToM scores. Thus, children that were able to detect others' mental states may not need empathy to comprehend that conduct which produces psychological harm is morally wrong and negatively affects the victim.

The findings of the two previous studies emphasize the importance of considering in tandem the affective and cognitive processes in order to fully understand the specific and potential reciprocal relationship between young children's evolving moral judgments and the underlying socio-cognitive mechanisms. Another important variable that needs to be considered when moral transgressions take place is *negligence*, both of the transgressor's and of the victim's. For example, if a child is on a swing (accidental transgressor) and another child being inattentive (victim) passes in front of the child on the swing and gets hit and falls down, the transgressor should be judged less harshly since the negligence of the victim accidentally contributed to the harm inflicted. Building on previous results of Mulvey et al. (2020) that showed that children consider both transgressors' and victims' negligence when evaluating moral-relevant situations, Gönültas et al. (2021) demonstrated that indeed, children consider both transgressors' and victims' negligence when making moral judgments in property damage and physical harm stories, and this ability is facilitated by false belief understanding.

Investigating the acceptability of transgressions across conditions (victim careful/transgressor negligent or victim negligent/transgressor careful) the authors (Gönültas et al., 2021) extended earlier research (Nobes et al., 2009) by emphasizing the importance of also considering the victims' negligence when making moral judgments. Children with higher ToM were more likely to consider the victim's negligence, especially in the physical harm story, compared with children with lower ToM. In the property damage story, children with higher ToM evaluated more negatively the negligent transgressor compared with children with lower ToM. This finding suggests that ToM might enable children to consider both the victim's and transgressor's intentions and actions when making moral judgments.

Another worth-mentioning finding of Gönültas et al. (2021) was that ToM accounted for children's *alternative actions proposals* (for both the transgressor and victim) in morally-relevant situations. Their results showed that children with more advanced ToM were more likely than children with lower ToM to suggest ways in which both the transgressor and the victim could have acted differently. This result suggests that ToM may favor the flexible consideration of alternative actions by envisioning different possible outcomes for different types of actions.

Interestingly, there was no difference in the acceptability judgments of the transgressor's negligence between children with higher ToM and children with lower ToM in the physical harm story. A possible explanation was that the negative outcome of the physical harm was more easily detected by children, irrespective of their ToM ability, compared to the intent detection in the property damage story, confirming studies showing that young children are particularly sensitive to harm infliction (e.g., Helwig et al., 1995, 2001). This result suggests that ToM may contribute only to some types of moral judgments (psychological harm, fairness judgments, property damage) and not to others (physical harm, rule-breaking). Moreover, different types of ToM (first-order ToM, second-order ToM, morally-relevant ToM) may have different contributions according to moral transgression type (prototypical standard transgression, morally-relevant transgression). Indeed, Fu et al. (2014) investigated the interrelationships between children's moral judgments of accidental and prototypic transgressions and first-order and second-order ToM. They showed that children's moral judgments were related to their first-order ToM. Moreover, children who performed better in a MoToM task made more accurate judgments about the intention of the accidental transgressor (e.g., throwing away a bag containing another's preferred object) than those who could not correctly attribute false beliefs to the victim and to the transgressor.

Fu et al. (2014) were the first to show that, even after partialling out the age effect, it was not first-order ToM but rather second-order ToM that helped children to accurately evaluate the accidental transgressor's intention. Children that were able to engage in this level of recursive thinking (e.g., that the victim thought that the transgressor thought that there was trash inside the bag) were more likely to judge the intention of the transgressor less negatively. This result is in concert with previous studies that found that children's second-order ToM also counts for responsibility attribution (Yuill & Perner, 1988). Fu et al. (2014) showed that second-order ToM was useful in situations where the children needed to coordinate multiple perspectives in order to make accurate judgments of wrongdoing (accidental transgression). However, when the intention and the action were not in conflict (prototypical transgression; pushing someone off the swing), second-order ToM was not significantly related to children's moral judgments.

Another study which showed that ToM predicted more favorable evaluations of the accidental transgressor is that of D'Esterre et al. (2019). The authors investigated ToM's role in children's ability to differentiate between intentional and unintentional false statements regarding claims to resources. Moreover, they found that MoToM predicted children's responses for all of the assessments above and beyond age and false belief understanding. Similarly, another study (Ochoa et al., 2022 a, b) reported significant results concerning

children's MoToM and their performance on moral judgment tasks. The authors used a morally relevant belief vignettes task as a dual assessment of false belief understanding and moral reasoning in a sample of 4- to 5-year-olds and found important developmental changes, compared to previous findings (Killen et al., 2011) indicating that it was only from the age of 7-8 years that children could integrate false belief understanding in morally-relevant contexts. Moreover, children performed worse on a morally-relevant vignette task than on a standard moral transgression task. They had difficulties with the intention and the consequences questions (true belief, bad intent). One possible explanation could be the complexity of the morally-relevant task (e.g., an undesirable object hidden in a box) as compared to the standard task (e.g., someone hurting their knee).

In the previous study, the vignettes featured two characters, one of whom (the agent) discovered in an opaque container a pleasant animal (kitten) and in another, an unpleasant animal (skunk). The agent decided to share (prosocial vs. antisocial behavior) one of these containers with another, after the animals switched their containers. For two stories the agent knew the contents of the container (true belief condition) and for other two stories, the agent had a mistaken belief about the contents (false belief condition). On the one hand, in the *true belief condition*, where the agent handed what they believed they would hand, a desirable pet (kitten; good intent) versus an undesirable pet (skunk; bad intent) all children performed well in evaluating intention and consequence. They evaluated the agent with the bad intention as being meaner and assigned more punishment compared with the good intent condition, irrespective of their ToM level. Moreover, the punishment evaluation matched the moral judgment in this true belief condition. On the other hand, in the *false belief condition*, where the agent unknowingly didn't manage to hand what they believed they would hand (offering a skunk even though they thought that in the box is the kitten they had put inside) children had difficulties with the intention question, especially those with low ToM. This result extends previous findings (Killen et al., 2011), showing that ToM enables children to make a more accurate intent evaluation in morally-relevant situations.

Nonetheless, only 5-year-olds with higher ToM were able to integrate intention in morally-relevant contexts (rating agents with false beliefs as more positively intentioned in good intent trials (even though the outcome was bad) than in bad intent trials (even though the outcome was good) as compared with 4-year-olds also with high ToM. Irrespective of their ToM level (low vs. high), 4-year-olds didn't manage to integrate intention in these contexts where intention and outcome were in conflict. 4-year-olds with higher ToM were able to detect that the agent had a mistaken belief about the contents of the box but were unable to use this knowledge to evaluate the agent's intention.

Punishment attribution

Punishment represents a penalty or a retribution directed toward those who inflict harm or violate social norms (Cushman, 2008). Even though prior research showed that moral judgment and deserved punishment attribution are highly correlated (Smetana, Jambon, et al., 2012), Ball et al. (2016) found a low to moderate correlation between these two ratings. Similarly, Ochoa et al. (2022a) found that moral judgment and punishment attribution were correlated but only in the true belief condition (as compared with the false belief condition, where even the 5-year-olds with higher ToM performed no better than chance). This result is in accordance with previous findings that showed that young children, especially those without false belief understanding, often focus more on outcomes when assigning consequences (Cushman et al., 2013; Zelazo et al., 1996). Moreover, Cushman et al. (2013) observed a lag between integrating false beliefs in intent judgments and doing so in punishment judgments.

The findings of Ochoa et al. (2022a) support Cushman et al.'s (2013) view and Zelazo et al.'s findings (1996), which showed that when processing demands were reduced, thus children could focus on relevant information, both 4-year-olds and 5-year-olds with higher ToM were able to correctly rate agents' intentions compared with 4 and 5-year-olds with lower ToM. Nonetheless, in Ochoa et al. (2022a) the simplification of the task did not have an impact on punishment attribution, with children being unable to integrate false beliefs into punishment judgments. Interestingly, all children made reference more often to mental states than outcomes when justifying punishment attribution. However, children with low ToM that incorrectly determined the agent's intention seemed to match the intent of the agent with the outcome in their justifications, thus still focusing on the outcome when evaluating deserved punishment. Another study (Ball et al., 2016) found that preschoolers with relatively low ToM did not distinguish between moral and conventional issues in judgments of deserved punishment. One possible explanation for this result could be the fact that both the moral and the conventional violations were presented without specifying the outcomes. Because both these violations are legitimately punishable, children low in ToM might have had difficulties in considering the supplemental information that needs to be analyzed in case of the moral violations in order to make more nuanced punishment attributions to these kinds of violations as compared with the conventional ones.

The previous results suggest that other factors besides ToM might influence children in their punishment evaluations. Ball et al. (2016) found that higher *empathy* was associated with ratings of greater deserved punishment for fairness violations but not for physical harm or, unexpectedly, for psychological harm. Thus, punishment may be particularly important in helping children

attend to and enforce issues of fairness. Correspondingly, as more empathic preschoolers tended to judge fairness violations as more serious than their less empathic peers, they also assigned more punishment. Empathy was not related to severity judgments regarding physical harm. One possible explanation could be that the child didn't need to take the perspective of the victim since the consequences were immediately evident. Thus, in the contexts where the outcomes are salient and the child sees the inflicted harm and doesn't need to infer it, empathy may not be necessary to identify and judge the harm as being punishable. Also pertaining to the affective processing when calculating deserved punishment, Seucan et al. (under review) showed that punishment was associated with the ability to understand other people's emotions. In their study, even though no information was offered about how the victim in the situation may be feeling, 3- to 5-year-olds who had a higher ability to infer other people's emotions correctly assigned more punishment to the bad character and less punishment to the good character. It is possible that having this ability allowed children to simulate whether the victim in the situation would be upset or happy if the agent carried on with the action (e.g., *'The brother will be sad if his sand castle gets wrecked by his sister.'*) and assign an appropriate punishment.

Apart from taking the affective perspective of the victim, children might also consider the negligence of the agent before deciding the amount of deserved punishment. Similar to Nobes, Panagiotaki, and Bartholomew (2016) and Nobes et al. (2017), the findings of Gönültaş et al. (2021) showed that children judged negligent actions as more punishable than careful actions. The authors showed that when children had to assign punishment, children with higher ToM scores were more likely to use both the transgressor's and the victim's negligence information in their judgments whereas children with lower ToM scores did not differentiate between their punishment judgments for the transgressor and victim. This finding indicates that ToM may enable children to shift between intention and outcome information when making moral judgments. Moreover, the punishment was differentiated based on ToM and story. In the property damage story, children with higher ToM scores were less likely to assign punishment when the victim was negligent. A possible explanation might be that children with higher ToM might have considered that having a special cupcake thrown away is punishment enough or that the victim simply forgot to label the bag containing the cupcake and that forgetfulness is not punishable. The fact that the same difference was not visible in punishment evaluations of the victim in the physical harm story, suggests that children might consider the type of harm elicited in different moral contexts before making their moral evaluations. In other words, the possible interaction between negligence and ToM might be diminished by the salience of the severity of the act.

Summary and future directions

The aim of the current scoping review was to investigate the relationship between theory of mind and children's moral judgment. The majority of the analyzed studies showed ToM to be directly related to moral judgment; one study found ToM to be a mediator between group membership and yet another found bidirectional links between ToM and children's moral judgment. Smetana et al. (2012) designed a 1-year three-wave longitudinal design to identify potential links between preschool children's ToM and their moral judgments in different contexts. They found significant bidirectional longitudinal associations between the two, with moral judgment leading to a more mature ToM, and also, with ToM enabling a more accurate evaluation of moral transgressions.

Concerning ToM influence on moral judgment, Smetana et al. (2012) found that children more advanced in ToM, although they considered moral rules as more alterable, they attributed less punishment. One possible explanation is that as children become more proficient in understanding the mental states underlying a complex moral action (e.g., coordinating their evaluation of the misdeed with possible psychological motives for why it happened), their moral judgments become more flexible and less absolutistic. Also, children with a higher ToM could take into account other factors (e.g., negligence of the transgressor and of the victim; Zelazo et al., 1996) that determined the transgressor to behave the way it did (e.g., the victim forgetting to label the bag containing the special cupcake), leading to lowered ratings of deserved punishment (Gönültas et al., 2021).

Concerning moral judgment's influence on ToM, it seems that ToM is influenced by children's efforts to understand and evaluate complex social relationships. Smetana and Braeges (1990) showed that starting with 2.5 years of age children can make accurate judgments in prototypical straightforward moral transgressions, even though at this age they do not have yet a first-order ToM understanding. Before the age of 4, when it is documented that children have a full-fledged ToM, they might evaluate the severity of acts by observing the effects of moral transgressions on others without inferring mental states (Sokol, Chandler, & Jones, 2004). This finding, that moral judgments enhance ToM is similar to results obtained in observational and longitudinal studies showing that family discourse (Dunn, 2006), and parental responses that focus the child on the victim's feelings in the context of moral transgressions (Ruffman et al., 1999) predict differences in children's ToM. These findings are also in line with the constructivist theory (Carpendale & Lewis, 2004) that highlights that children's ToM develops from communicative interactions and social relationships with others.

Concerning the reciprocal links between ToM and moral judgment, children's day-to-day experiences with moral transgressions (e.g., hitting, pushing, exclusion from play, unwillingness to share, rule-breaking, and teasing) supply them with a rich socio-moral environment that encourages and facilitates the development of mental state understanding. But as this skill develops, children become better at analyzing and understanding complex moral settings where intentions do not match outcomes, or other factors need to be considered before making a moral decision (e.g., group biases, negligence; emotion understanding; Glidden et al., 2021; Gönültaş et al., 2021; Seucan et al., under review).

The studies with ASD children also add valuable information regarding the relationship between the two variables of interest. Garcia-Molina et al. (2019) showed that ASD children had greater difficulty than TD children in recognizing and explaining intentionality and action-morality in basic moral stories. Significant differences were found between the two groups in their justifications, showing that ASD children failed to apply the required ToM ability to understand and judge the intention and morality of the act. In a later study, investigating also preadolescents with ASD (7- to 12-years old), Garcia-Molina et al. (2022) found that ASD children as compared with TD children had difficulties in understanding the moral transgressions when the action directly affected another person (e.g., having the desire to take revenge on another person) but not when it affected an object (e.g., having the desire to obtain an object belonging to someone else by stealing it). The difference between these two types of judgments could stem from the fact that in the former case, the child needs to understand the mental states of the transgressor, with his specific desires and beliefs. Second, there is the understanding that the victim, who is affected by the action, also has a mind and does not know the information about the transgressor's desires.

Regardless of whether the cases are ambiguous or unambiguous, to resolve them correctly, the mental states of the victim and of the transgressor need to be integrated, thus imposing a greater complexity for ASD individuals (Moran et al., 2001; Zalla et al., 2011; Zalla & Leboyer, 2011) and even for TD children at younger ages (Killen et al., 2011). Also, when they had to evaluate the intention and the agent's morality, ASD children rated the agent in faux-pas scenarios as "bad" even if the intention was previously rated as "good". Their responses might be influenced by the bad outcome (e.g., 'she was hurt by his remark') even when the agent's intention was understood (e.g., 'he wanted to help her'). Thus, a discrepancy arises when the moral context is ambiguous, ASD children base their judgment on the outcome and not on the intention, suggesting that autistic individuals could have ToM-related deficits as a stumbling block in their moral judgment performance (Margoni & Surian, 2016a).

The studies reviewed seem to indicate that both conceptual changes and information processing improvements are likely implicated in the integration of ToM within moral judgments. Considering the processing demands, numerous studies have shown that executive functioning impacts ToM development (e.g., Carlson & Moses, 2001; Devine & Hughes, 2014). Specifically, as executive functioning is necessary but not sufficient for ToM, it may be that they are not sufficient for integrating ToM within moral reasoning. Even when processing requirements were reduced and the methodological adjustments did improve 4-year-olds' evaluations of intention, punishment judgments were not improved (Ochoa et al., 2022). Even when processing requirements were reduced and the methodological adjustment did improve 4-year-olds' evaluations of intention, punishment judgments were not improved (Ochoa et al., 2022a). Thus, as Cushman et al. (2013) have argued, the incorporation of ToM into punishment evaluations may require a further conceptual advance. According to their results, they conclude that two systems (outcome-based vs. intent-based) operate in determining punishment judgments. Across development, a conceptual reorganization occurs such that the intent-based system increasingly constrains, but does not fully override outcome-based punishment judgments. These arguments of Cushman et al. (2013) found recent support in Ochoa et al. (2022a) study results but need further investigation to portray a clearer picture of children's moral act evaluation and punishment attribution.

Even though the studies included in this scoping review have a valuable contribution to the field of moral development, there are several **limitations** to be considered. The main limitation of the studies included refers to the correlational, cross-sectional nature, reducing the possibility of making inferences about causal influences or reciprocal links between ToM and moral judgment. Longitudinal research would be ideal for investigating this relationship more thoroughly. Another limitation is the limited types of moral transgression (e.g., property damage, physical harm) investigated in studies trying to untangle children's moral reasoning. Future research could include moral situations involving resource allocation, social exclusion, and deception. In addition, the fixed order of the questions might prime children in their subsequent responses given that Nobes et al. (2016) showed that children's answers are influenced by this methodological adjustment. Also, to better understand how the first-, second-order ToM, and MoToM interact with each other to influence children's moral evaluations, explicit questions evaluating second-order ToM could be embedded within the story (e.g., "What does the victim think that the transgressor thought was inside the bag?").

Future directions are also worth advancing in order to inform the researchers which aspects regarding children's moral reasoning need further

clarification. Future studies could include a more widespread age range, evaluating school-aged children and adolescents' moral reasoning to better capture any variation in the maturation of moral judgment. Also, longitudinal designs are needed to shed light on the mechanisms related to social-cognitive abilities and children's moral judgments in social interactions as the relations among these processes may vary across different developmental periods. Smetana et al.'s (2012) longitudinal results not only highlighted that ToM and moral judgment are interrelated but also that they have causal influences on each other. Future studies should further investigate these links and also, see if these links exist between ToM and the other two forms of moral reasoning from Social Domain Theory (societal and psychological; Turiel, 2006).

In order to determine what features of the complex situation envisioned by the accidental transgression were difficult to process and evaluate by children, a wider range of potential transgressions should be used. Moreover, developing new MoToM tasks for different types of transgressions would be helpful for future research. Also, varying other aspects of the context such as the agent's familiarity (e.g., friends, siblings, strangers), or the nature of the misdeed. Moreover, the development of early moral concepts may also be influenced by moral emotions. For instance, Hoffman (2000) has suggested and Kochanska et al. (2002) have demonstrated that guilt following indiscretions enables children to better understand moral contexts. Future research should examine how moral emotions like guilt or shame shape children's harm infliction evaluations.

The study by Glidden et al. (2021) showed that MoToM was not a mediator between intention evaluation and ingroup bias in the intentional unfair condition, but only in the other two conditions (intentional fair and unintentional unfair), suggesting that children's MoToM ability might be context-dependent. Future research could investigate when and why children rely on their morally-relevant ToM. Also, including tasks that assess children's interpretive ToM could enable us to see how children interpret a morally-relevant situation based on the characters' emotions and their position in the event (Ross, 2006), thus opening new avenues for research. Investigating other cognitive factors, such as language (Dunn et al., 2000; Milligan et al., 2007) and executive functioning might explain the mechanism behind the relationship between ToM and moral judgments (Buon et al., 2016). A great body of research, both cross-sectional and longitudinal, documented the tight links between ToM and executive functions (see Devine & Hughes, 2014, for a meta-analysis), as interindividual variation in ToM was found to be due to executive functioning (Devine & Hughes, 2014). Thus, future research should investigate if executive functions (e.g., inhibitory control, shifting) may be an explanatory factor in the role of individual variation of ToM in children's moral judgments of transgressions.

These results have important *implications* for moral education, as teachers might facilitate young children's understanding of moral contexts by requiring them to consider all aspects of a transgression and help them take the perspective of both the transgressor and victim into account when making moral judgments and possible punishment decisions. In complex moral interactions, educators could help children integrate intention and outcomes while also considering additional information (e.g., negligence, group biases). Furthermore, these findings also have important implications for understanding how social-cognitive abilities interact with information about the victim and the transgressor's intention (and negligence) to influence children's decision-making processes in different socio-moral contexts.

Conclusion

ToM is an essential prerequisite for children's moral judgment. It is more predictive than age when it comes to making accurate moral reasoning. Moreover, second-order ToM and MoToM are better predictors than both age and first-order ToM (D'Esterre et al., 2019), showing that children need to be capable of complex recursive thinking when judging complex moral settings. When compared with classical ToM measures (e.g., location false belief task; content false belief task), children's MoToM abilities are better at predicting children's moral understanding and reasoning. One possible explanation might be that MoToM represents a more ecologically valid measure by requiring children to ascribe mental states in socially and morally multifaceted complex scenarios. Nonetheless, future studies should develop new MoToM tasks, as current results point to the fact that MoToM ability might be context-dependent.

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Relationships between smoking habits, subjective health status, life satisfaction, and happiness among the police officers of a Hungarian region

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ABSTRACT. Aim: The aim of the study reported in this paper is to describe the smoking habits of police officers and examine the relationships that can be found between smoking habits, subjective health status, life satisfaction, and happiness. **Methodology:** The mapping of smoking habits served as a component of a research questionnaire prepared as part of the health promotion activities of police officers. In addition to smoking habits, the respondents had to assess their health (subjective health), life satisfaction, and happiness. **Findings:** The proportion of smokers in the population studied is as follows: 42.6% have never smoked, 24.9% quit smoking, and 32.4% still smoke. Subjective health status showed a weak but significant association with happiness ($p=0.329$) and life satisfaction ($P=0.343$). **Value:** Special attention should be given to smoking and planning the development of health promotion programs. The poor association of happiness and life satisfaction with subjective health status continues to emphasize mental and psychological health in addition to physical health.

Keywords: Police, smoking, subjective health status, happiness, life satisfaction

ZUSAMMENFASSUNG. In der Studie handelt es sich um die Rauchgewohnheiten von Polizisten. Welche Zusammenhänge gibt es unter Rauchgewohnheiten, subjektivem Gesundheitszustand, Lebensfriedenheit und Glück. **Methodik:** Die Erfassung von das Gesundheitsverhalten von Polizeibeamten wurde Forschungsfragebogen als Bestandteil des Rauchverhaltens erstellt. Neben den Rauchgewohnheiten mussten die Befragten ihre Gesundheit (subjektive

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Gesundheit) Lebenszufriedenheit und ihr Glück beurteilen. **Ergebnisse:** Der Anteil der Raucher unter den untersuchten Population: 42,6 % haben noch nie geraucht, 24,9 % haben mit dem Rauchen aufgehört und 32,4 % rauchen noch. Der subjektive Gesundheitszustand ist schwach, aber es hat signifikanten Zusammenhang mit Glück ($p=0,329$) und Lebenszufriedenheit ($p=0,343$) gezeigt. **Wert:** Auf Rauchen muss weiterhin eine besondere Aufmerksamkeit durch Gesundheitsförderung gewidmet werden. Die schlechte Assoziation mit Glück und Lebenszufriedenheit, mit dem subjektiven Gesundheitszustand wird nicht nur die körperliche Gesundheit, sondern auch die psychische und geistige Gesundheit betont.

Schlüsselwörter: Polizei, Rauchen, subjektiver Gesundheitszustand, Glück, Lebenszufriedenheit

Introduction

“Health promotion is the process of enabling people to increase control over, and to improve their health. To reach a state of complete physical, mental, and social well-being, an individual or group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope with the environment. Health is, therefore, seen as a resource for everyday life, not the objective of living. Health is a positive concept emphasizing social and personal resources, as well as physical capacities. Therefore, health promotion is not just the responsibility of the health sector but goes beyond healthy lifestyles to well-being.” (Ottawa Charter, 1986).

The goal of the Hungarian National Police Headquarters' occupational health promotion activities (The Life-Strength-Health Program) is to reduce health-damaging behaviors and, at the same time, increase health awareness and the occurrence and effectiveness of activities that serve health (Tánczos, 2021). It also has an explicit aim to promote psychological well-being and mental health both at the individual and organizational levels (Malét-Szabó, 2015). In our whole project, we would like to map the areas that should be given priority in health promotion programs.

This study examines the relationships between subjective health status, smoking habits, happiness, and life satisfaction.

Smoking among police officers

Smoking is one of the most significant public health problems worldwide, the consumption of tobacco products is among the causes of premature death. It is the main health risk that could be avoided (WHO, 2021).

In studies describing research on similar topics, survey questions and different categorization do not match exactly our research questions, so they can only be suitable for an approximate comparison.

Boyce's results published in 2006, the average age of their sample (514 police officers) was 34.8 years. 79% of the participants in the study did not smoke, while 21% identified themselves to be smokers. The average age of men who smoked was higher, while no such difference could be detected in the case of women (Boyce, 2006).

In 2008, one of the results of a study on metabolic syndrome in India found that only 22.6% of police officers smoked (Tharkar, 2008).

Basaza (2020) in a survey among police officers in Uganda found that the highest prevalence of smoking was in the 25-33 age group with 48.0%, followed by the 34-44-year-olds, with 36.0%, the 18-24 year-olds with 16.0%. Among officers, 25.2% of males and 27.8% of females reported current smoking, which is significantly higher than the general Ugandan population (16% males, 3% females). The smoking rate was 25.5%, compared to 5.3% of the general population. In the police population risk factors for smoking included higher education (Basaza, 2020).

Jankowski conducted a cross-sectional study among Polish police officers in 2020 where they found that 19.5% of the respondents smoked daily, and 13.4% smoked occasionally. 3.1% of the respondents stated that they use e-cigarettes daily and 3.2% use e-cigarettes occasionally (Jankowski, 2021).

In 2015, Khan conducted a survey among police officers in Bangladesh. About half of the respondents (48.6%) had never smoked. A quarter of the respondents (25.9%) had smoked but quit, and 25.4% were current smokers. Among current smokers, 7.0% were occasional smokers while 18.4% were daily smokers. (Khan, 2019)

The subjective state of health, life satisfaction, happiness

Psychology uses many terms and tools to describe well-being. According to Shiota (2022), it would be necessary for clarity of concepts on both the theoretical and research side, which helps the accuracy of the measurements supporting in this way research about the causes and consequences of well-being. Different types of subjective well-being are associated with longevity and different health outcomes. (Sadler 2011; Diener, 2017; Howell, 2007) Subjective well-being and health behavior are also closely related (Baker, 2020; Stenlund 2021, 2021, 2022). Diener also draws attention to the fact that this complex phenomenon needs further studies to understand it (Diener, 2017).

Ottmann (1989) dealt with the subjective health status of officers, assessing the somatic complaints of workers with different work schedules. Researching the relationship between happiness and health, Kushlev (2017; 2020) found that happiness has a positive effect on physical health. There are research findings that happiness and well-being are not directly related to mortality (de Souto Barreto, 2016; Liu, 2016). Liu (2016) concluded that part of the association between unhappiness and mortality, particularly cancer mortality, is mediated by smoking.

In this study, subjective health status, life satisfaction, and happiness are the focus. However, due to methodological differences, it is possible to make a comparison between the studies.

Method

Sample

The research was carried out in 2020 and 2021. The target population of the research was the staff of the Szabolcs-Szatmár-Bereg County Police Headquarters. A complex set of questions on health and health behaviour included questions about smoking habits, happiness, and life satisfaction. Before starting to fill out the questionnaire, those intending to participate in the research received written and verbal information about the questionnaire and its voluntariness. The participants started completing their answers only after giving their written consent.

After clarifying the relevant information needed to write this study, the sample size is 1212 people, of which 86% are men (1046 people) and 14% are women (166 people). The average age is 39 years, the youngest is 22 years old, and the oldest is 62 years old. There is no significant difference between men's and women's ages, the average age of women is 39.36 (standard deviation: 8.0) and the average age of men is 38.89 (standard deviation: 7.9).

The highest educational level for 16.99% of the respondents is secondary school education, 46.61% of the sample have attended law enforcement school while 34.98% have a higher education degree (Fig. 1).

RELATIONSHIPS BETWEEN SMOKING HABITS, SUBJECTIVE HEALTH STATUS, LIFE SATISFACTION, AND HAPPINESS AMONG THE POLICE OFFICERS OF A HUNGARIAN REGION

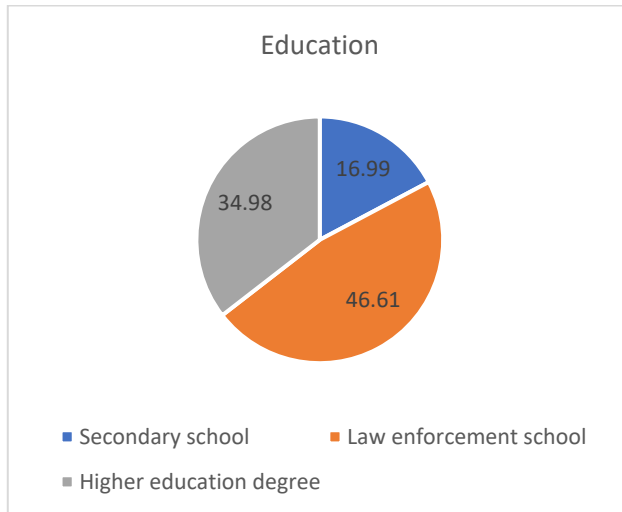


Fig. 1. Education

In terms of length of service, respondents with 16-25 years of service accounted for approximately half of the sample (16-20 years of service: 24.42%; 21-25 years of service: 21.78%), with respondents with more than 30 years of service being the least represented in the sample (3.46%) (Fig. 2).

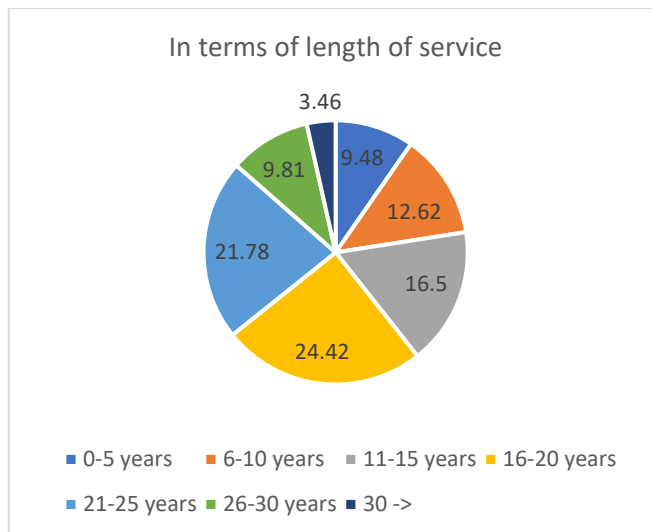


Fig. 2. In terms of length of service

In addition to the traditional socioeconomic characteristics (gender, age, educational level), the questionnaire also includes the time spent in the workforce as a characteristic. The factors we examine include the subjective health status, happiness, and life satisfaction. In the questionnaire, we asked the following question for the subjective perception of health: Overall, how would you rate your own state of health? The answer had to be evaluated on a 5-point Likert scale, in which the options ranged from 1-very bad to 5-excellent.

The results showed that 65.4% of men classified their health status as good. 17.8% of men rated their subjective health status as excellent, and 16% as medium. 0.1% and 0.8% of male respondents rated it bad or very bad. The 1 person who gave a very bad rating belongs to the age group between 46-50. The 8 people who gave 0.8%, a bad rating, are spread across among the age groups. (Fig. 3)

For women, the subjective health status is as follows: no respondent gave a very bad or bad rating, 14.5% gave a medium rating, 67.5% gave a good rating and 18.1% gave an excellent rating to the female respondents (Fig. 4).

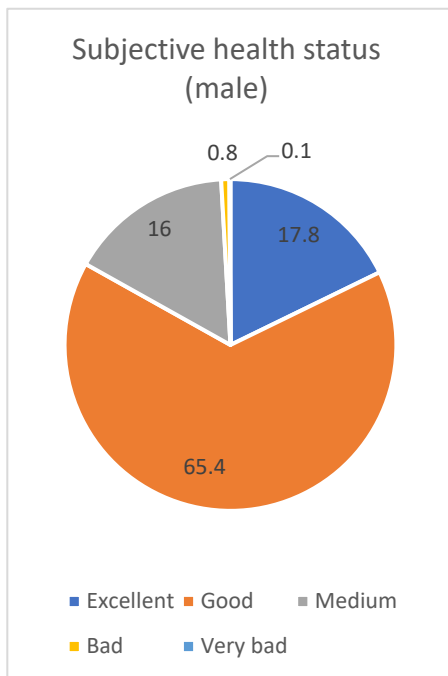


Fig. 3. Subjective health status (male)

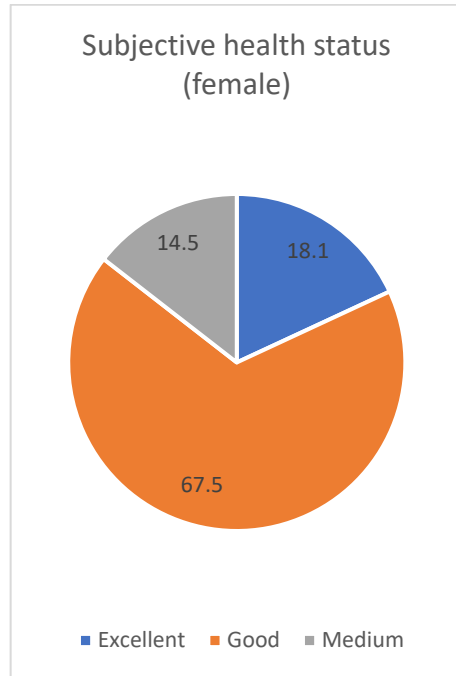


Fig. 4. Subjective health status (female)

RELATIONSHIPS BETWEEN SMOKING HABITS, SUBJECTIVE HEALTH STATUS, LIFE SATISFACTION, AND HAPPINESS AMONG THE POLICE OFFICERS OF A HUNGARIAN REGION

In the context of smoking, we used the following question in the current analysis: *Which statement is true for you?* 1. never smoked, 2. used to smoke, but no longer, 3. still smoke now.

In terms of smoking, 41.9% of men have never smoked, 25.4% used to smoke but no longer, and 32.7% of respondents are smokers.

In the case of women, 47.0% have never smoked, 22.3% used to smoke but no longer, and 30.7% still smoke.

Summing up the smoking habits of men and women, the sample is as follows: 42.6% have never smoked, 24.9% no longer smoke, and 32.4% still smoke. 67.6% of the staff do not smoke (Fig. 5).

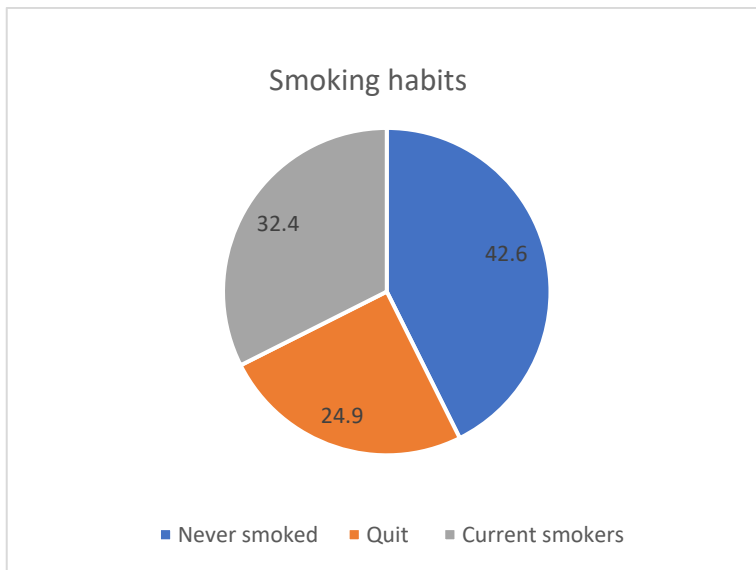


Fig. 5. Smoking habits

Regarding smoking, we found no significant differences in the different age groups. (Table 1)

Table 1. Age category and smoking habits (crosstabulation)

Age category	Smoking habits			Total
	Never smoked	Quit	Current smokers	
<25	34,4%	23,4%	42,2%	100.0%
26-30	45,6%	14,0%	40,4%	100.0%
31-35	44,1%	22,6%	33,3%	100.0%
36-40	35,7%	30,5%	33,8%	100.0%

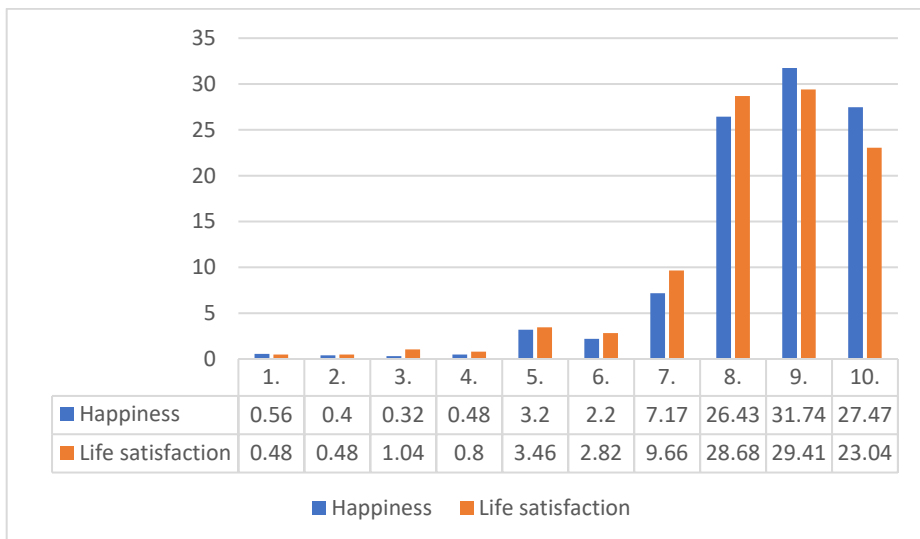
Age category	Smoking habits			Total
	Never smoked	Quit	Current smokers	
41-45	44,6%	24,5%	30,9%	100.0%
46-50	42,4%	31,8%	25,8%	100.0%
51-55	46,3%	24,1%	29,6%	100.0%
>56	40,0%	40,0%	20,0%	100.0%
Total	41,9%	25,4%	32,7%	100.0%

Those who rated their subjective health status as bad or very bad are treated separately in further statistical calculations. Men and women are treated as one sample for further analysis.

We asked about life satisfaction with the following question: *Overall, how satisfied are you with your life these days?* They were able to indicate their answer to the question on a 10-point Likert scale, in which 1 is completely dissatisfied and 10 is completely satisfied with their lives.

The question to measure happiness: *How happy do you consider yourself overall?* They were able to indicate their answer to the question on a 10-point Likert scale, where 1 represents unhappy and 10 represents completely happy. Responses related to satisfaction and happiness are presented in Table 2.

Table 2. Happiness and life satisfaction distribution



RELATIONSHIPS BETWEEN SMOKING HABITS, SUBJECTIVE HEALTH STATUS, LIFE SATISFACTION, AND HAPPINESS AMONG THE POLICE OFFICERS OF A HUNGARIAN REGION

The values of life satisfaction and happiness show a high degree of correlation ($p=0.825$).

We used the correlation coefficient regarding the relationships between life satisfaction, happiness, and subjective health status. Subjective health status showed a weak but significant association with happiness ($p=0.329$) and satisfaction ($P=0.343$).

The Kruskal-Wallis test was used to examine the association of smoking-related behavior. According to the results, there is no clear significant difference between subjective health status, ($H=4.039$, $p=0.133$), "satisfaction with life" ($H=3.106$; $p=0.442$), and "happiness" ($H=1.634$; $p=0.442$) about smoking, but there are trend-like differences.

Kruskal-Wallis Test

	Smoking habits	N	Mean Rank
Subjective health status	Never smoked	513	608.10
	Quit	300	621.57
	Current smokers	390	578.93
	Total	1203	
Life satisfaction	Never smoked	513	619.12
	Quit	300	602.24
	Current smokers	390	579.29
	Total	1203	
Happiness	Never smoked	513	614.00
	Quit	300	603.19
	Current smokers	390	585.30
	Total	1203	

Test Statistics (Kruskal Wallis test; Grouping Variable: Smoking habits)

	Subjective health status	Life satisfaction	Happiness
Chi-square	4.039	3.106	1.634
df	2	2	2
Asymp.Sig.	.133	.212	.442

Discussion

The prevalence of smoking is high, as every third person among our respondents is a smoker (32.4%). This rate is also high in international comparison, Boyce (2006) found that 21% of police officers smoke, according

to the Indian survey (Tharkar, 2008) 22.66% is the rate of smokers. Ugandan law enforcement officers are among 25.5% of smokers (Basaza, 2020). In Poland, 13.4% of law enforcement officers declared themselves smokers (Jankowski, 2021), and in Bangladesh, the proportion of smokers was 18.4% (Khan, 2019).

Regarding smoking, even though public health programs and the legal regulations on the protection of non-smokers have made smoking subject to strict conditions, smoking still cannot be excluded from health promotion programs.

The sample who was present with a small number of elements is indicative, in the sense that health and psychological care activities should probably be carried out with them on an individual level in order to avoid possible somatic or psychological illnesses or to support their recovery.

In our study, smoking shows a weak trend-like correlation with subjective health status, happiness, and life satisfaction. According to the results of Lappan (2020), smoking predicts worse life satisfaction after 4 years. In this regard, it may be interesting to analyze the data in this direction, this could be a planned comparative analysis in the future.

If the goal is to support your physical and mental health, then it is advisable to keep in mind Ngamaba's finding (2017) that better health (both objective and subjective) is also associated with higher life satisfaction. According to Velten (2014), the more health behavior domains are at a favorable level, the stronger satisfaction with life is. Considering the above concepts, it is worthwhile to include both physical and mental well-being programs in health behavior changes during health promotion programs.

Limitations of the survey

The factors we examine are complex in themselves, the question is really very complex. Happiness and life satisfaction, as well as subjective health status, are influenced by many factors.

The sample has a much higher number of males compared to the female sample. However, this is in line with the proportions found in law enforcement.

The present study presents the partial results of a complex health awareness and health behavior questionnaire. To reduce the length of the original questionnaire, it was necessary to minimize the number of questions. For the measurement of Happiness and Life Satisfaction, a multi-item instrument would have been more appropriate due to its better psychometric properties.

At the beginning of the survey in 2020, electronic smoking devices were not yet as popular, so we did not specify which tobacco product we mean by smoking: traditional smoking habits or more recently used electronic devices.

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Conflicts of interest / Competing interests: The authors have no conflict of interest to declare.

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Operationalizing collaborative problem-solving skills: A framework for assessment and development in the digital age

Sergiu MAXIM^{1,*}

ABSTRACT. This article delves into the operationalization of collaborative problem-solving (CPS) skills, focusing on the essential aspects required to effectively apply CPS in the modern digital age. The article emphasizes the growing significance of CPS skills as technology-based work and the automation of routine tasks demand proficiency in addressing non-routine, complex challenges. To enable successful CPS, a new set of skills including information literacy, divergent thinking, and problem-solving, both individually and collaboratively, are explored. The article investigates the strategies and approaches employed by individuals and teams when engaging in collaborative problem solving, with an emphasis on knowledge sharing and skill pooling. The study highlights the criticality of CPS as an invaluable skill set, enabling individuals to effectively collaborate and overcome intricate problems. Moreover, as contemporary work environments increasingly rely on successful group problem solving, the significance of operationalizing CPS is expected to continue growing in the future.

Keywords: collaborative problem solving, problem solving, PISA, literacy, Human-to-Human, Human-to-Agent, Twenty-first Century Skills.

The twenty-first century is dominated by collaborative settings and teamwork in both the academic and professional industries. This is why work environments have started to depend highly on successful problem solving in a

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group context. Although collaboration has been a highly researched topic as part of several psychology spheres until today, collaborative problem solving as a construct is still relatively new.

1. What is Collaborative Problem Solving and why is it important?

1.1. Definitions

Collaborative Problem Solving has been described as the ability to “effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills and efforts to reach that solution” (Krkovic et al. 2017, p. 13, cf. OECD 2013).

Given that problem solving means having a specific situation to analyze and resolve, there are two different processing types, depending on the nature of the problem: static (simple) and interactive (complex) problem solving. A situation becomes a problem whenever the path from the starting point towards the goal is ambiguous and a solution can only be reached by using non-routine activities. This requires from the solver a specific cognitive process, as the solution is not obvious. (Krkovic et al., 2017)

1.2. Related concepts CPS and Problem solving

The following concepts emerge as related to both collaborative problem solving and problem solving:

Assessment: Several articles cited in this review discuss the assessment of collaborative problem solving, including the use of computer-based assessments and the potential for computer agents to replace humans in the assessment process. The articles also touch on the importance of developing standardized assessments for collaborative problem solving.

Education: The changing role of education and schools is discussed, with a focus on how these changes impact the development of problem-solving skills in students.

Perspective-taking: the role of individual perspective-taking within a group in collaborative problem solving.

Competency Model: A generalized competency model of collaborative problem solving which highlights the importance of various competencies in successful collaborative problem solving.

PISA Framework: The Organisation for Economic Co-operation and Development (OECD) developed a framework for measuring collaborative problem solving as part of the Programme for International Student Assessment (PISA).

Shifts in Assessment: the shifts in the assessment of problem solving, which have moved from traditional paper-based tests to computer-based assessments and assessments of collaborative problem solving.

In their case study Bull et al. (2018) explore the use of Minecraft as a virtual world for collaborative problem-solving activities. They discuss how the interactive and immersive nature of Minecraft can facilitate the development of problem-solving skills in students.

Overall, collaborative problem solving and problem solving are closely related concepts, and there is a growing interest in developing assessments and frameworks to measure both. Additionally, we emphasize that education is important in developing these skills, as is the need for perspective-taking and a generalized competency model to guide the development of collaborative problem-solving skills.

1.2.1. Static Problem Solving vs. Complex Problem-Solving Tasks

In static problem solving, the difficult part in reaching a solution is finding the best way to handle the process, as both the problem's initial state and goal are clearly defined from the start. Krkovic et al. (2017) exemplifies this with the task of putting together a piece of furniture without having instructions. The problem solver has all the necessary parts, tools and knowledge of what the furniture should look like when put together, the only missing part being putting the pieces together where to start, what the best order of actions is, which parts fit together, and which tools to use for which parts.

In contrast, complex problem solving implies dealing with inaccurate problems with unclear starting and ending points. The problem solver needs to do an extra effort in order to gain more knowledge before or while managing the situation. Some authors give the example of repairing a car with highly interdependent parts. Here, the problem solver needs to explore several possible reasons that could account for why the car is not running, make changes to its parts, monitor how these changes influence the functioning of other parts and the general functioning of the vehicle. On the basis of the information gathered, the solver will make subsequent repairs and reevaluate the progress. The focus of the investigation may shift as a result of the problem solver's interaction with the car or the interdependency of the parts of the vehicle.

Hence, it can be concluded that complex problem solving implies two distinct dimensions: acquiring the necessary knowledge, all while interacting with a dynamic setting and possible changes in the process and applying that knowledge by always having the end goal in mind. Added to the equation, collaboration in both static and complex problem solving refers to two or more people working together, trying to solve a problem and reach a unified solution by sharing knowledge and skills.

Greiff et al. (2014) have focused on the assessment of collaborative problem-solving skills in technology-rich environments and address the challenges involved in assessing these skills, providing recommendations for designing effective assessments that capture the complexities of collaborative problem solving.

In terms of capacities and skills involved in collaborative problem solving, Griffin and colleagues conceptualize it as consisting of five broad strands, the capacity of an individual to: recognize the perspective of other persons in a group; participate as a member of the group by contributing their knowledge, experience and expertise in a constructive way; recognize the need for contributions and how to manage them; identify structure and procedure involved in resolving a problem; and, as a member of the collaborative group, build and develop knowledge and understanding (Griffin et al., 2012).

Csapó & co's 2018 literature review examines the role of education in the development of problem-solving skills, discussing various educational approaches and strategies that can enhance problem-solving abilities in students, emphasizing the importance of fostering these skills from an early age.

1.3. Importance

Collaborative problem solving is an important skill for individuals to possess as it allows them to work effectively with others to solve complex problems. The articles cited hereby highlight the importance of collaborative problem solving in a variety of contexts, including education and assessment.

One article by Sun et al. (2018) presents a generalized competency model of collaborative problem solving that highlights the importance of various competencies, including communication, coordination, and shared understanding. The authors argue that these competencies are essential for successful collaborative problem solving.

The OECD also recognizes the importance of collaborative problem solving and has developed a framework for measuring this skill as part of the PISA assessment (Organisation for Economic Co-operation and Development,

2017). The framework emphasizes the importance of interpersonal and intercultural skills, as well as cognitive skills, in collaborative problem solving.

Hayashi (2017) provides further evidence of the importance of collaborative problem solving in a study that investigated the role of individual perspective-taking within a group. The study found that individuals who were able to take on the perspectives of others were more effective in solving complex problems collaboratively.

Overall, these articles highlight the importance of collaborative problem solving in a variety of contexts and emphasize the need for individuals to possess the competencies necessary to effectively work with others to solve complex problems. Collaborative problem solving has become increasingly important in today's globalized and interconnected world, where individuals must work with others from diverse backgrounds and perspectives to tackle complex challenges.

2. Operationalization of CPS

2.1. What Skills Does CPS Include?

Many changes took place in daily life during the past decades, especially since the advancement and modernization of technologies lead to a technology-based society. Many of the tasks that used to be repetitive and manually labored in the past are now automated and done by robots instead of people. Human employment is nowadays more common in non-routine, complex tasks that require a new set of skills, more digital-friendly but also from a cognitive complexity perspective. Examples of such skills, better known as twenty-first century skills, are information literacy, divergent thinking (“thinking out of the box”), and problem solving (on both an individual and a collaborative level) (Krkovic et al., 2017).

Not only is this transition happening in the economic environment, but also in schools and educational systems. Instructional methods have been stressing the importance of developing and using complex problem-solving skills especially through self-exploratory tasks such as laboratory experiments or programming tasks. All these radical shifts require people to look differently at daily problems, by approaching them more flexibly and dynamically. The more complex the problem gets, the more likely it is for managers and employees to solve it in a collaborative way. This is also valid for schoolwork or even in personal or family settings.

As much as collaboration involves multiple actors, each one of them brings in an individual contribution and a particular set of skills in order to reach a successful problem-solving process. In 2012, PISA identified four processes that make up individual problem solving (OECD, 2017):

- gathering information related to the problem
- representing the problem and the various relationships in the problem with tables, graphs, symbols or words
- devising a strategy to solve the problem and carrying out this strategy
- ensuring that the strategy has been followed and reacting to feedback obtained during the course of solving the problem

These four processes are still relevant to the problem-solving aspects of the PISA 2015 collaborative problem-solving assessment. In addition, there are three competencies specific to collaborative problem solving:

- establishing and maintaining shared understanding (finding out what other team members know and ensuring that team members share the same vision of the problem)
- taking appropriate action to solve the problem (determining what collaborative actions need to be performed – for example, who does what? – and then executing these actions)
- establishing and maintaining team organization (following one's own role in the problem-solving strategy and checking that others also follow their assigned role)

Individuals' cognitive abilities and social skills are thought to be best expressed while interacting with each other in a group. Sun and colleagues (2018) consider therefore CPS as a process that hinges on individuals' and group's ability to establish a common ground concerning the nature of the problem, develop a solution plan, monitor progress along the way, and accommodate multiple perspectives while respectfully managing disagreements.

As much as cultivating students' and workers' collaborative problem-solving skills is essential nowadays, there are some significant challenges in operationalizing CPS mainly because it contains hard to measure aspects as behavioral and collaborative ones. The main challenge, as presented by Krkovic and colleagues (2017) is to include all the relevant sub skills and at the same time maintain the important psychometric criteria such as objectivity, reliability, validity, and scalability. Frequent concerns that arise in the operationalization of CPS are presented in the same paper and include the following:

- Could the frequency of collaborative acts be used as an indicator of the quality of collaborative work? In particular, how many collaborative acts does it take to make the collaboration more efficient and effective?

- Are there specific styles of collaboration that rely on personality traits that need to be considered in the operationalization?
- Can judgments of collaboration on an individual level be made when, in reality, the person will always need to deal with different team members and may act differently according to the situation?

Over the years, there has been a shift from experimental research to empirical studies which lead to different approaches to operationalizing the individual problem-solving construct, all of them being based on computer-supported scenarios. There are two types of scenarios – realistic and formal – depending on the applied tools' structure and semantic cover, also known as “cover story”.

2.2. Realistic Scenarios

This type of scenario was the first one ever to appear in research on individual complex problem solving, starting with the Lohhausen system. In this scenario, the problem solver acts as a mayor of a fictional village where he possesses all the decision-making power, as long as the community stays satisfied with its living conditions. Realistic scenarios such as this one are structured by deliberately chosen relations between variables in the system (i.e., ad hoc systems), which are commonly based on one face-valid task.

One of the most important benefits of these scenarios is their face validity, because they are commonly semantically rich and therefore able to simulate the complexity of the real world. As any other study and system, this one is not exempt from limitations either, especially regarding their psychometric properties – low objectivity due to unclear achievement criteria or questionable reliability. Some researchers even suggest that the complexity of these scenarios does not adequately represent the complexity of the real world (Krkovic et al., 2017).

2.3. Formal Scenarios

These scenarios appeared as a response to the realistic scenarios' limitations and are based on a priori set structural equations, which are characterized by multiple short tasks. The development of formal-based scenarios had a strong impact on including complex problem solving in LSAs, since the new approach offered better psychometrical properties of the tasks, as necessary in a large-scale context.

In particular, formal systems are usually based on multiple items that have a specific underlying structure, the goal of which is to enable more reliable and valid assessment. Since Funke (1985, 1999) first introduced the use of formal systems in task development, a number of individual complex problem-solving scenarios have been based on them, for instance Multiflux, Genetics Lab, MicroDYN and MicroFIN.

The formal-based scenarios differ according to the structure of the system they are based on. Consequently, the formal systems can be categorized as two different types: linear structural equation (LSE) systems and finite state automata (FSA). While LSE systems tend to be rather homogeneous in their structure, the FSA systems are heterogeneously structured. This, in turn, determines how broadly aspects of complex problem solving may be captured, depending on the instrument used. Introducing the LSE and FSA conducted a considerable development of the psychometric qualities of complex problem-solving simulations (Krkovic et al., 2017).

In the case of Linear Structural Equation (LSE) Systems, the problem simulation consists of various input and output variables, where the problem solver can only manipulate the inputs. Not only does one output variable change based on the test taker's decisions, but also based on a function of time or as a side effect from another changed output variable. Advantages of such systems include the fact that they can be structured as a multiple-item test; they allow for a wide range of difficulties; and it will take participants a shorter amount of time to complete the tasks.

As for the Finite State Automata (FSA), these systems include various nonlinear features without following any pattern. Although it is still a matter of input and output variables influencing each other, in this case the problem solver needs to explore the perfect interaction of the input variables, in order to achieve the desired results. Therefore, a variable has an influence on the outcome from only a specific value onwards, which could require from the test taker more complex problem-solving skills.

2.4. Human-to-Human versus Human-to-Agent Settings

Assessing collaborative problem solving is commonly realized through two distinct types of interactions: human-to-human (H-H) and human-to-agent (H-A). Although both settings present advantages, there are also some limitations attached to each one which have been debated in the literature for a while now. Over time, researchers have investigated how much these two settings differ and in which conditions is the students' performance higher when completing the assessments.

While human-to-human is considered to be a more natural and face-valid approach, the human-to-agent approach allows creating a more standardized assessment setting. One empirical study example from an incipient research phase on the subject is the one implemented by Rosen (2015) in which 179 students aged 14 from the United States, Singapore and Israel were asked to complete CPS tasks in both settings, having identical methods and resources. One major difference identified, which also makes the H-A approach more attractive is its possibility to provide more opportunities for students to demonstrate their CPS skills. While interactions with human partners could be limited to a particular amount of possibilities, the H-A mode allows programming a much wider range.

Another meaningful finding was that interacting with a computer agent involves significantly higher levels of shared understanding, progress monitoring, and feedback and thus, a higher performance. However, the two models seem to be similar enough in terms of motivation and ability to solve the problem of the students involved. Eventually, the author considers that models can be as equally effective as long as they are adapted to particular educational purposes. In the case of highly trained teachers in subjects such as communication and collaboration, using H-H settings is recommended as it could be a more powerful tool in students' learning process. On the contrary, when students do not have a higher CPS level, technology can fill the gaps with its computer agents-based assessments and bring an improvement to the individual evaluation process.

As much as human-to-human interactions may seem more personalized, flexible and enriching, human-to-agent settings can equally adopt flexible strategies that permit a large space of alternative conversations, context-sensitive rules and change-adaptive processes. Even nowadays, people communicate with each other more through virtual tools rather than face-to-face, so H-A settings are becoming pretty indispensable. Computer agents can be programmed depending on multiple factors starting from concrete, non-human specific ones to behavioral and social aspects that can be controlled.

This concern of whether or not H-A interactions are an accurate approximation of H-H interactions was also approached by OECD (2017) in a study which concluded the following:

- There were no practically relevant differences between students' responses to the two versions of the collaborative problem-solving tasks
- Teachers' opinions of their students' collaboration skills correlated well with their students' performance in the computer-based collaborative problem solving assessment

- Some students performed several collaborative problem-solving tasks in an H-A format before performing a couple of tasks face-to-face with another person through unrestricted interaction. Their performance with the computer agent was a moderately good predictor of their performance with the human partner.

Given that this study was done as well with the purpose of identifying the effectiveness of PISA computer-based assessment, it concludes that human-to-agent settings can still describe students' ability to collaborate with other humans.

There is no doubt that there are differences between the way students collaborate with other human beings and with computer agents. In other words, agents could actually replace humans as collaboration partners in CPS assessments. This was also one of the reasons why, three years later, Herborn and colleagues (2018) conducted a study to validate the PISA 2015 CPS assessment mentioned above by investigating the effects of replacing computer agents with real students in classroom tests, therefore by using a human-to-human setting.

The authors obtained the otherwise confidential PISA 2015 CPS tasks, reformatted and redesigned them, used an identical interface and the predefined chat design, and had students communicate with one another by selecting from a fixed set of chat options. This H-H condition was indeed constrained by these chat options, but less constrained than the H-A condition. In total, 386 students from 9th and 10th Grade in Germany and Luxembourg participated to this research. All of them were informed about which types of partners they were collaborating with, in order to emphasize a likely effect of the collaboration partners' nature on the main test takers.

Eventually, while the results did not suggest any performance accuracy differences, behavioral actions such as clicking, dragging and dropping, or moving elements of the tasks, registered some differences compared to the PISA 2015 assessment in H-A format. Specifically, students collaborating with classmates interacted slightly more frequently during the tasks than those collaborating with only the computer agents, thus more time was spent on solving the tasks in the H-H format. However, as these differences were small enough and did not affect actual performance, they do not seem to limit the comparability of H-A and H-H tasks.

This study also showed how human-to-human settings allow for more natural communication and external effects (e.g., group composition or the collaboration partner's CPS proficiency) on the main test-taker's performance. Clearly, computer agents will not replace actual humans in collaborations anytime soon, but they are certainly increasingly integrated in educational settings and workplace environments.

3. Main CPS Assessment Tools

Everything that we know up to now about collaborative problem solving is due to multiple research, studies and experimental assessments completed over time. This chapter aims to summarize several examples of the assessment tools used in testing and measuring collaborative problem solving.

3.1. Assessment and Teaching of Twenty-first Century Skills (ATC21S) Project

This project was the first large-scale assessment of CPS targeting students between 11-15 years old. It relied on human-to-human, computer-supported collaboration where students were randomly matched to work together in various problem situations. The assessment closely followed two main categories of skills: social and cognitive.

The main social skills include participation, perspective taking and social regulation (negotiation, self-evaluation and taking group responsibility). Cognitive skills include planning, systematically executing solutions and monitoring progress, learning and knowledge building. Thus, team members needed to identify the problem structure and procedures, collect and assess information required to build solutions, and engage in strategic problem solving (Sun et al., 2018). Despite all problems being different in content, all of them required from students to use these skills and collaborate with each other in order to find the solution.

Krkovic et al. (2017) illustrates the structure of ATC21S through the balance beam task, shown in Fig. 1. Here, two participants work on a typical problem-solving task – bringing the scale into balance by using different weights. To do so, participants need to collaborate by exchanging tools back and forth, communicating their ideas, and discussing plans. Thus, the task collects information about students' collaborative skills and how they apply these skills in complex problem-solving contexts.

The project provides students and teachers with an instant report, thus further strengthening its formative purpose. The ATC21S project pioneered the use of real collaboration in the assessment of collaborative problem solving in large-scale settings and is therefore the most advanced project yet developed for exploiting the qualitative information that comes from the interactions of collaborating dyads.

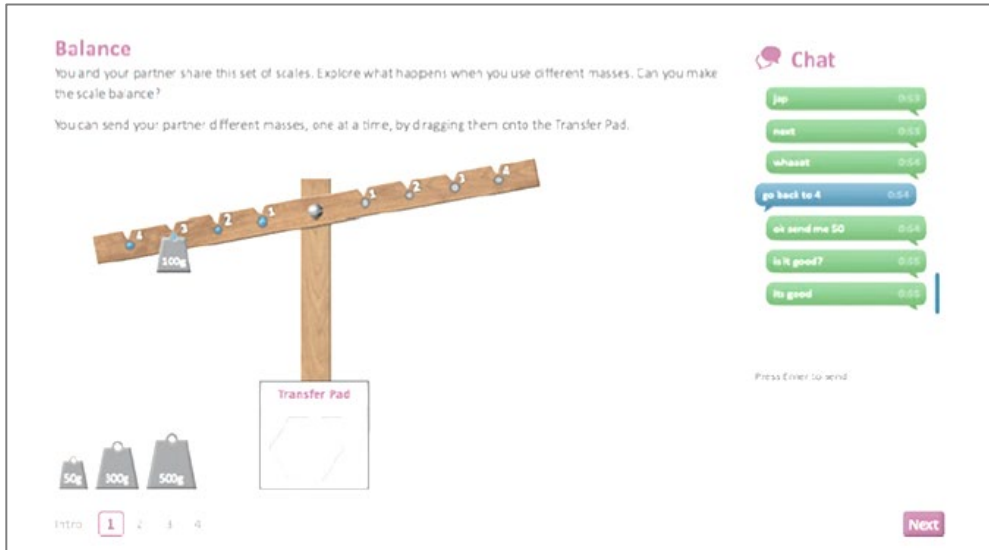


Fig. 1. ATC21S task example: The balance beam task (Krkovic et al., 2017)

3.2. Rosen and Foltz (2014) Study – Comparison between H-H and H-A

Rosen and Foltz (2014) opted to measure the concept through one H-A evaluation test and an H-H one, together with a quantitative measuring instrument. The latter involves assessing the motivation of individuals to work in the given task. It consists of four items, and the answer consists of a four-point Likert scale (1 = strongly disagree, 4 = strongly agree). Its items have been taken from the literature and include: “I felt interested in the task”; “The task was fun”; “The task was attractive”; “I continued to work on this task out of curiosity” (Rosen, 2009; Rosen and Beck-Hill, 2012). The fidelity of the instrument, also referred to as internal consistency, was 0.85.

The computerized task of measuring collaborative problem solving skills (CPS) involves collaborating with another partner, either a virtual agent (avatar) or a classmate. This involves finding the best conditions for an animal in a zoo, with the aim of extending its life expectancy. Life expectancy is constantly displayed during the task. The student had the freedom to choose different foods, living habitats and additional options. All this time, both partners could see choices by making and communicating via chat. In this chat, 4-5 response options could be selected, which change depending on the context

of the tasks. By approaching this of the predefined choice of messages, the authors were able to monitor and measure collaboration and communication skills (e.g., Hsieh and O'Neil, 2002).

These predefined communication messages with each other, along with CPS process measurements, were automatically recorded based on the type of message used for each situation. Specifically, each message was coded a priori as representing each of the CPS abilities. At the beginning of the task, the student and partner were encouraged by the researchers to discuss the best approach to achieving the best conditions for the animal, and at the end of the task, each individual was asked to provide feedback about the partner's performance.

The level of difficulty of the task was relatively low and served as a platform for the overall assessment of CPS skills. This was due to the centrality of the collaboration dimension in CPS. At the same time, due to the exploratory nature of the study, the participants were not limited either in the number of trials or in terms of time - both necessary to find the optimal solution for the situation. However, the task was designed in such a way that at least two attempts to solve the problem and at least one act of communication with the partner were needed to complete the assessment task.

In the case of H-A setting, the agent (Mike) had the responses scheduled with different characteristics relevant to different CPS situations (e.g. to agree or disagree with the participant, either to contribute to or to confuse the problem, etc.). This approach gave each student similar optimal chances to show their CPS skills.

As for results evaluation, the problem-solving dimension was assessed by one point for each year of the animal's life expectancy achieved. The score for the shared understanding dimension consisted of a limited number of initial questions asked by the participant at the beginning in a pre-defined appropriate; the answers to the partner's starting questions were also monitored. The score for monitoring progress was calculated based on the communication initiated by the student before the final registration of the chosen variables.

At the same time, for this dimension, the student's statements based on the displayed life expectancy results were also taken into account. The feedback dimension was evaluated by two teachers, independently, from US schools. They evaluated the students' written answers on a Likert scale from 1-4. The inter-evaluator fidelity on this dimension was 92%. Grammar errors were not taken into account, only what related to CPS.

3.3. Collaborative Science Assessment Prototype (CSAP)

The Collaborative Science Assessment Prototype (CSAP) project was developed to measure, according to its title, the field of science. It consists of six practical challenges based on the literature (Hao et al., 2017).

Five evaluation tools were administered:

1. A standalone test for general science knowledge consisting of 37 multiple-choice items adapted from the Scientific Literacy Measurement (SLiM) instrument (Rundgren, Rundgren, Tseng, Lin, & Chang, 2012).
2. A personality survey, Ten Item Personality Measure (TIPI) (Gosling, Rentfrow, & Swann, 2003).
3. A demographic survey adapted from the National Assessment of Educational Progress (NAEP, 2013).
4. Two versions of a web-based science simulation task on volcanoes:
 - a. Collaborative version (a.k.a. Tetralogue): Two participants collaborate to interact with two virtual agents in the simulation to complete a science task on volcanoes.
 - b. Single-user version (a.k.a. Trialogue): A single participant interacts with two virtual agents in the simulation to complete a science task on volcanoes.
5. A post-collaboration satisfaction survey.

The Trialogue simulation was developed to measure students' scientific exploration skills, using multiple choice answers, constructed responses (CRs) and conversational items. The task requires three people working together to solve it. In this simulation, students interact with two virtual agents, one of whom plays the role of co-elderly student, respectively mentor of the student. The goal is to complete a scientific task about volcanoes.

The individual task was used by researchers with two objectives in mind: on the one hand it served as a control option to verify the effect of collaboration, and on the other hand the authors used the answers provided by participants as baseline for item properties (e.g. correct item ratio). The collaboration version included the option to communicate through a chat for the two participants and another chat, which allowed the team to communicate with agents, thus the title of Tetralogue.

Moreover, the authors designed a four-step response procedure in the collaborative version of the simulation task, by which it captures each team member's science inquiry skills before and after the collaboration. The procedure for responding to a question in the simulation is as follows:

1. Each participant is prompted to respond to the item individually before any collaboration.
2. Each participant is prompted to discuss the item with her partner.
3. Each participant is prompted to revise her initial response if she wants.
4. A representative is randomly chosen to submit a team answer.

In this way, the responses before collaboration capture each individual member's science inquiry skills specific to the task, while the changes in responses after the collaboration reflect how effective the collaboration was and it allows to probe directly which CPS sub-skills may be more important for better collaboration outcomes.

3.4. Collaborative Problem Solving in PISA 2015

According to Ramalingam (2017), although PISA assesses mainly reading, mathematics and science abilities, from time to time it includes evaluations that go beyond this spectrum, such as problem solving (in 2003, 2012 and 2015). Acquiring high levels of problem-solving skills is the foundation for future learning, for effective participation in society and for the proper conduct of personal activities. It basically involves the application of learned knowledge to new situations.

The first attempt to assess collaborative problem solving in PISA was in 2012 on the grounds that it comprises essential skills for a successful hiring after school where teamwork is indispensable. Although this did not succeed due to significant challenges of that time, experts and literature made possible the addition of CPS tasks in PISA in year 2015. Here, 52 educational systems participated in this cross-cultural and national evaluation.

A number of existing models and frameworks were reviewed in order to conceptualize the key processes involved in CPS. The conceptualizations of collaborative skills differ in the details across the models, but there are a number of correspondences and some convergence. Eventually, three core competencies were adopted in the PISA 2015 CPS framework, namely: establishing and maintaining shared understanding, taking appropriate action to solve the problem, establishing and maintaining team organization (OECD, 2017).

As students develop collaborative problem-solving skills, the complexity of the problems they can solve increases, which is directly impacted by the clarity of the tasks' objective, the number of people involved in the same workgroup or even their motivation, engagement and openness to collaboration.

A single score summarizes students' overall proficiency in CPS. To illustrate what the score means, PISA has adopted an approach to reporting survey outcomes that involves the development of learning metrics, which are

dimensions of educational progression. Four levels of proficiency are identified and described in Table 7 in an overall reporting scale for CPS to enable comparisons of student performance between and within participating countries and economies (OECD, 2017).

Table 7. Proficiency scale descriptions for CPS

Level	What students can typically do
4	At Level 4, students can successfully carry out complicated problem-solving tasks with high collaboration complexity. They are able to solve problems situated in complex problem spaces with multiple constraints, keeping relevant background information in mind. These students maintain an awareness of group dynamics and take actions to ensure that team members act in accordance with their agreed-upon roles. At the same time, they are able to monitor progress towards a solution to the given problem and identify obstacles to be overcome or gaps to be bridged. Level 4 students take initiative and perform actions or make requests to overcome obstacles and resolve disagreements and conflicts. They can balance the collaboration and problem-solving aspects of a presented task, identify efficient pathways to a problem solution, and take actions to solve the presented problem.
3	At Level 3, students can complete tasks with either complex problem-solving requirements or complex collaboration demands. These students can perform multi-step tasks that require the integration of multiple pieces of information, often in complex and dynamic problem spaces. They orchestrate roles within the team and identify information needed by particular team members to solve the problem. Level 3 students can recognise information needed to solve a problem, request it from the appropriate team member, and identify when the provided information is incorrect. When conflicts arise, they can help team members negotiate a solution.
2	At Level 2, students can contribute to a collaborative effort within a problem space of medium difficulty. They can help solve a problem by communicating with team members about the actions to be performed. They can volunteer information not specifically requested by another team member. Level 2 students understand that not all team members have the same information and are able to consider different perspectives. They can help the team establish a shared understanding of the steps required to solve a problem. These students can request additional information required to solve a given problem and solicit agreement or confirmation from team members about the approach to be taken. Students near the top of Level 2 can take the initiative to suggest a logical next step, or propose a new approach, to solve a problem.
1	At Level 1, students can complete tasks with low problem complexity and limited collaboration complexity. They can provide requested information and take actions to enact plans when prompted. Level 1 students can confirm actions or proposals made by others. They tend to focus on their individual role within the group. With support from team members, and working within a simple problem space, these students can contribute to a problem solution.

Table 8. Matrix of CPS skills for PISA 2015 (OECD, 2013)

	(1) Establishing and maintaining shared understanding	(2) Taking appropriate action to solve the problem	(3) Establishing and maintaining team organization
(A) Exploring and understanding	(A1) Discovering perspectives and abilities of team members	(A2) Discovering the type of collaborative interaction to solve the problem, along with goals	(A3) Understanding roles to solve problem
(B) Representing and Formulating	(B1) Building a shared representation and negotiating the meaning of the problem (common ground)	(B2) Identifying and describing tasks to be completed	(B3) Describe roles and team organization (communication protocol/rules of engagement)
(C) Planning and executing	(C1) Communicating with team members about the actions to be/ being performed	(C2) Enacting plans	(C3) Following rules of engagement, (e.g. prompting other team members to perform their tasks.)
(D) Monitoring and reflecting	(D1) Monitoring and repairing the shared understanding	(D2) Monitoring results of actions and evaluating success in solving the problem	(D3) Monitoring, providing feedback and adapting the team organization and roles

4. CPS Assessment by using AI tools

Collaborative problem-solving assessment can be done using AI tools in several ways. One approach is to use machine learning algorithms to analyze data collected from collaborative problem-solving tasks. For example, Herborn et al. (2018) used machine learning techniques to analyze data from the PISA 2015 collaborative problem-solving assessment and found that computer-based agents were able to accurately assess students' collaborative problem-solving skills.

Another approach is to use natural language processing (NLP) techniques to analyze students' interactions during collaborative problem-solving tasks. Rosen and Foltz (2014) used NLP to analyze chat logs from a collaborative problem-solving task and found that their automated system was able to accurately assess students' collaborative problem-solving skills.

Furthermore, AI tools can be used to provide real-time feedback to students during collaborative problem-solving tasks. For example, Hao et al. (2017) developed an AI-based system that provides real-time feedback to students during a collaborative problem-solving task, which has the potential to enhance their problem-solving skills.

In summary, AI tools can be used to assess and provide feedback on collaborative problem-solving skills using techniques such as machine learning and natural language processing. Such tools have the potential to enhance the assessment and development of collaborative problem-solving skills, particularly in the context of online and distance learning.

5. Conclusions

Collaborative problem solving is a critical construct that encompasses the joint efforts of multiple agents in resolving problems through the sharing of knowledge, understanding, and collaborative endeavors. It encompasses two distinct problem-solving types: static (simple) and interactive (complex), with the latter involving intricate tasks characterized by ambiguous initial states and goals. Complex problem solving necessitates the acquisition of additional knowledge while engaging with dynamic environments, all while keeping the ultimate objective in mind.

The modern digital age underscores the increasing significance of collaborative problem-solving skills, as traditional routine tasks become automated, making room for non-routine and complex challenges that demand a fresh skill set. Consequently, there is a burgeoning interest in developing assessments and frameworks to effectively measure and enhance collaborative problem-solving skills. Education plays a pivotal role in cultivating these skills, emphasizing the need for perspective-taking and a generalized competency model that can guide their development.

However, the operationalization of collaborative problem-solving skills presents challenges, primarily related to the measurement of behavioral and collaborative aspects while ensuring compliance with rigorous psychometric standards, including objectivity, reliability, validity, and scalability. To address this, researchers have explored different approaches to operationalizing individual problem-solving constructs using computer-supported scenarios. These approaches encompass realistic scenarios, which simulate real-world complexities through carefully crafted relationships between system variables, and formal scenarios, characterized by a priori structural equations and multiple short tasks that offer enhanced psychometric properties.

Assessment tools have been developed to evaluate collaborative problem-solving skills. Notably, the Assessment and Teaching of Twenty-first Century Skills (ATC21S) project is a large-scale assessment targeting students aged 11-15. It employs human-to-human, computer-supported collaboration to assess the social and cognitive dimensions crucial to collaborative problem

solving. Additionally, Rosen and Foltz's (2014) study compares collaborative problem solving through human-agent and human-human evaluations, monitoring communication and collaboration skills via predefined messages and process measurements.

Collaborative problem solving assumes paramount importance in the modern era, where effective problem resolution in group contexts is increasingly sought after. Its development and assessment remain pivotal to individuals' abilities to navigate complex challenges alongside their peers. Future research should delve into exploring the untapped potential of collaborative problem solving, identifying effective instructional strategies, and unraveling its implications across diverse domains. This academic pursuit will facilitate the advancement of knowledge in collaborative problem-solving skills and contribute to the growth and success of individuals and teams in various professional settings.

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Teaching applications of mathematics: The effect of the intervention on the participating teachers*

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ABSTRACT. The purpose of this study is to examine the effect of the intervention with teaching applications of mathematics in other disciplines on teachers' attitudes towards teaching applications of mathematics. The research was conducted in the 2021-2022 school year in Israel and a two-groups pretest-posttest quasi-experimental research design was used. The participants were four classes (two of them are 11th grades and two are 12th grades) with four teachers at Al-Bukhari High School in Arraba city in northern Israel. The research instruments were three interview guides. The first interview was conducted before the intervention with all the 4 teachers and it contained 16 questions about their attitudes toward teaching mathematics and applications of mathematics. The second and third interview was similar and it was conducted during respectively after the intervention with the teachers in the experimental group. These interviews contained 5 questions related to teaching applications of mathematics in other disciplines.

The results of the study showed that teaching applications of mathematics in other disciplines has a positive effect on teachers. Before the intervention, the teachers taught using the standard method, and they rarely taught applications. The teachers were not qualified enough to teach applications of mathematics and were not aware of the advantages of teaching applications of mathematics. By the intervention teachers were exposed to the inclusion of applications in teaching mathematics, and their attitudes towards teaching applications of mathematics improved and their level of confidence to teach applications increased significantly (increased from 7 to 9 on a scale from 1 to 10). That means, the intervention helped the teachers to teach the applications of mathematics successfully and with self-confidence. Furthermore, despite the

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difficulties and the obstacles in teaching applications of mathematics in other disciplines, teachers liked to teach the applications of mathematics and were satisfied with the results and the change among the students. They reported that they would implement the teaching applications of mathematics in other disciplines in all classes that they teach and would recommend it to their fellow teachers.

Key Words: applications of mathematics, attitudes towards teaching mathematics, mathematics teachers

1. Introduction

In the literature of teaching mathematics, many articles have investigated the importance of teachers' and students' attitudes towards teaching mathematics and especially teachers' attitudes and the effect of these attitudes on students and teaching mathematics in general (Relich & Way, 1994; Skemp, 1976; Tuimavana & Datt, 2017).

Teachers' positive attitudes not only directly have a positive effect of learning mathematics among students and among their attitudes towards mathematics (Maria, 1992; Karp, 1991), but also influence teachers' teaching. For example, teachers with positive attitudes towards teaching mathematics use methods that are attractive and interesting to students, which causes positive attitudes of the students towards learning mathematics. This study shows the opposite: teachers who use attractive teaching methods, in this case "teaching applications of mathematics in other disciplines" will have positive attitudes towards teaching mathematics.

In this regard, the present study aims to find out the effect of teaching applications of mathematics in other disciplines on teachers' attitudes towards teaching mathematics. Teachers' attitude is studied by structured interviews before, during, and after an intervention with teaching applications of mathematics in high school mathematics classes.

The hypothesis of the study is that the intervention "teaching applications of mathematics in other disciplines" has a positive effect on teachers' attitudes towards teaching mathematics.

2. Literature review

The effects of teachers' positive attitude towards teaching mathematics

Teachers' attitudes towards teaching mathematics are very important and play a major role in teaching mathematics and in teaching in general. The studies that researched this subject showed the great and the wide influence of

the teachers' attitudes on teaching mathematics among students, on the attitudes of the students towards learning mathematics, on the successes of the students in mathematics, on the teaching methods of the teachers, and on the daily practice in the classroom (Maria, 1992; Skemp, 1976; Wilkins, 2002).

In the following several number of researches are presented that dealt with these issues and with teaching applications of mathematics in other disciplines and the interaction between them. Regarding to teachers' attitudes towards teaching mathematics, the studies of Maria (1992) and Tuimavana and Datt (2017) showed that there is positive effect between the attitudes of teachers towards teaching mathematics and the attitudes of students towards learning mathematics, which means: positive attitudes of the teachers towards teaching mathematics lead to positive attitudes of the students towards learning mathematics. Like this result, studies showed that negative attitudes of the teachers towards teaching mathematics have a negative effect on the students and create negative attitudes towards learning mathematics and cause a passive learner (Baturo & Nason, 1996). We can conclude that there is a big effect of the teachers' attitudes towards teaching mathematics among students' attitudes towards mathematics and at the same time there is an obvious effect of students' attitudes towards mathematics on students' success in mathematics. Many studies have shown that people with positive attitudes toward mathematics do better and are more successful than people with negative attitudes (Bayturan, 2004, Reyes, 1984; Ma, 1997).

Thus, the most important effects of teachers' attitudes towards teaching mathematics are on the students' successes in mathematics.

Therefore, in our opinion, there should be training for mathematics teachers on this subject and to make sure that the attitudes of teachers towards teaching mathematics must be positive in order to boost the students' attitudes and their achievements in mathematics.

In addition, many articles have investigated the effect of teachers' attitudes towards teaching mathematics among teaching methods and the procedure of the mathematics lessons and the daily practice of the mathematics class. Teachers' attitudes influence the teacher's methods and strategies. The result of teachers' positive attitudes is the use of methods and strategies that help students improve their understanding of mathematics (Amato, 2004).

Teaching applications of mathematics in other disciplines

Although there are not many studies in the literature of teaching applications of mathematics in other disciplines, the studies that dealt with this topic proved the importance and the benefits of it among both students and

teachers. So teaching applications of mathematics allows the student to see the importance of mathematics in everyday life, sees the beauty of mathematics, the connection of mathematics to the various fields of science, helps the students to understand and visualize mathematics, increases the student's motivation to learn, to love and enjoy learning mathematics, also causes to change students' attitudes towards mathematics for better and finally improves the student's achievements (Asli & Zsoldos-Marchis, 2021).

Several articles showed positive effects and the benefits of teaching applications of mathematics in other disciplines on students and teachers' attitudes toward teaching mathematics. For example, Yildirim and Sidekli, (2018) showed that applications of mathematics in STEM disciplines had a positive effect on mathematical literacy developed higher-order thinking skills in pupils and students as well. These applications also significantly influence students' attitudes towards mathematics studies, which led to an increase in academic motivation and an increase in the percentage of students with academic success.

In addition, teaching applications of mathematics enhances the learning atmosphere in math classes and turns a routine atmosphere into an active one for both teachers and the students as well as students' attitudes towards teaching mathematics have changed for the better and this led to a significant improvement in student achievement (Asli & Zsoldos-Marchis, 2022).

As we mentioned above, several articles and studies dealt with teachers' attitudes towards teaching mathematics and the importance of teaching applications of mathematics in other disciplines, but none of them dealt with the relation between teachers' attitudes and teaching applications of mathematics. This study is new in the field because it examines the effect of a new factor "teaching applications of mathematics in other disciplines" on teachers' attitudes towards teaching mathematics.

It is expected that new teaching methods and learning strategies that not all teachers are aware of and use such as "teaching applications of mathematics in other disciplines" will change teachers' attitudes towards teaching mathematics in a positive way, which is reflected positively on the students as well. This idea is consistent with the model of teacher professional of Clarke and Hollingsworth (2002) which is based on the fact that a change in one field is related to a change in another field. In the case of the current study, a change in teaching methods "teaching applications of mathematics in other disciplines" brings a positive change in the teachers' attitudes towards teaching mathematics. Clarke and Hollingsworth add that teachers must undergo professional growth that incorporates key features of contemporary learning theory. That is, the teachers must undergo professional development in order

to adapt themselves to the changes taking place and to the reality that changes every day. Furthermore, Guskey (1986) stated that significant changes in beliefs and attitudes are expected to occur only after significant changes in teaching outcomes. That means a change in the teaching results is related to a change in the teachers' beliefs and attitudes.

3. Methodology

3.1. Aim of the research

The aim of this research is to study the effect of the intervention with teaching applications of mathematics on teachers' attitudes towards teaching applications of mathematics.

3.2. Research instrument

The research instruments in this study are interview guides.

The first interview includes 16 questions about teachers' attitudes towards teaching mathematics and teaching applications of mathematics. It was applied before the intervention to teachers in both experimental and control groups.

The second and third interviews are similar, and they include 5 questions about teaching applications of mathematics. These interviews were applied only to the teachers in the experimental group and took place during and after the intervention.

3.3. Participants

The study involved four teachers and four classes from an Israeli high school. The name of the teachers will be abbreviated in the following with R, E, K and Re, where the acronym are initials of the following names: "R" =Reem, "E"= Eatedal, "K" = Kholod, "Re"= Reman. There are two 11th grade and two 12th grade participating classes. Each class is divided into two groups which are taught by different teachers at the same time (this is common practice for teaching mathematics in high school in Israel). Thus, one of the groups of each class was selected for the experimental group, the other one for the control group.

Regarding the level of education of the teachers, the four teachers have bachelor's degrees, all of them teach 11th and 12th grades and prepare the students for the matriculation exams in Israel.

Table 1 below contains the age and seniority in teaching of the teachers participating in the research.

Table 1. Data of age and seniority in teaching of the teachers participating in the research.

Teachers` name	Age	Seniority in teaching
“R”: Reem	36	13
“E”: Eatedal	28	6
“K”: Kholod	46	23
“Re”: Reman	35	10
Average	36.25	13

It is important to note that the youngest teachers are in the experimental group and the oldest in the control group for reasons of motivation and readiness for change and full cooperation with the research.

The control group included two teachers and 51 students, 25 students from grades 11-1 and 11-2 and 26 students from grades 12-1 and 12-2.

The experimental group included two teachers and 50 students, 25 students from grades 11-1 and 11-2 and 25 students from grades 12-1 and 12-2.

Each class is taught by two teachers at the same time and in fact each teacher from the studied teachers teaches two groups. The division of classes and teachers is presented in Table 2 .

Table 2. The division of participants classes and teachers in the research.

Teacher	Class	Group type
R	11-1 first half	Control
E	11-1 second half	Experimental
K	11-2 first half	Control
E	11-2 second half	Experimental
R	12-1 first half	Control
Re	12-1 second half	Experimental
K	12-2 first half	Control
Re	12-2 second half	Experimental

3.4. Data Analysis

The data obtained with the interviews before the intervention were analyzed identifying categories and themes (Shkedi, 2007). In the case of the teachers who participated in the intervention, their answers at the three interviews (before, during, and after intervention) were presented as case studies.

3.5. Intervention

The material studied during the intervention was “differential and integral calculus”, in particular, maximum and minimum problems. The same subjects were taught in both groups (control and experimental) and in both 11th and 12th grades. The 11th and 12th grades studied minimum and maximum problems for different types of functions: 11th grades for polynomial, rational, and root functions, and 12th grades for logarithmic, trigonometric, exponential, and power functions. In the experimental group also applications in other disciplines such as physics, construction, and economics of minimum-maximum problems were included. The intervention plan given to teachers contained the proposed examples of applications of mathematics in other disciplines for the subject taught. The plan also recommended the use of active teaching methods.

4. Results

4.1. The findings of the pre-intervention interviews

The findings of the interviews with the teachers in the two experimental and control groups before the intervention showed that *mathematics is an important subject* and is considered the basic subject of the other subjects and should be devoted more time and resources because mathematics is important for students for their studies and in everyday life as well as in future academic studies.

R: “Mathematics is considered a cornerstone of many areas and professions in our lives. We use mathematics a lot and it is the basis for many fields and disciplines [...]. Mathematics develops and strengthens our thinking and expands our horizons to other areas and disciplines.

Re: “It is important because we use and apply mathematics in everyday life [...].

It is a subject which develops students’ cognitive abilities, such as logical thinking, which is important in studying other subjects.

E- “Mathematics is one of the major and important subjects that is taught in the education system. Mathematical thinking imparts abilities such as problem identification, reasoning, and the use of solving aids, so mathematics allows student to think and solve problems and helps him in all sorts of areas of daily life”.

The interviewed teachers reported also *difficulties and obstacles in teaching mathematics*. Some of the difficulties are related to students such as their difficulties in understanding mathematics and solving mathematical problems, their lack of motivation for learning.

E: "Teaching math is not an easy task. One of the difficulties in teaching mathematics is the lack of motivation for students to learn. Most students see that mathematics is a difficult and irrelevant profession. Another obstacle is that mathematics is not intuitively connected to the student's emotional world. And for many students, math is a dry and difficult subject".

Other difficulties are related to financial, and time constraints.

K: "[...] lack of equipment and materials for illustration, time pressure and exams [...]."

As regarding the topic of the intervention, teaching applications of mathematics in other disciplines, one teacher reported that she occasionally teaches some applications, two rarely show applications, and one teacher never teaches applications. They teach applications in physics, economics, construction, and everyday life.

E: "Yes, I teach applications of mathematics in other disciplines, but not much, it depends on the time and topic being studied, if I am teaching a topic that can be applied in disciplines that I know, then yes I am teaching."

All the teachers see a difference between lessons with and without applications of mathematics. *Teaching applications of mathematics in other disciplines has many benefits*: students will become more interested in learning mathematics (stated by teachers R, K, Re, E) because they see the importance of mathematics (R, K) and its connection with everyday life (R). Because of the increased utility perception of mathematics, mathematics becomes more attractive (R), students' motivation for learning increase (K, E) and they understand mathematical notions deeper (Re, E). This leads to a more successful learning of mathematics (Re).

Re: "[...] By the application of mathematics in other disciplines and in daily life, the student feels the importance of mathematics, sees its beauty, see that mathematics is interesting [...]"

Despite the high importance of teaching applications of mathematics, teachers face *difficulties and obstacles* related to the educational system, the pressure of the matriculation exam (R, K, Re, E). Teachers feel the time pressure for finalizing the study material before this exam as the study material is huge.

Thus, there is lack of time for including applications in the lessons (R, K, Re, E). Another important difficulty is teachers' and students' lack of knowledge in the field of the applications (R, K, Re, E).

E: "It is difficult to teach mathematics applications in other disciplines when the discipline is unknown to the student or teacher."

Another difficulty is lack of necessary equipment (R, K). Presenting applications of mathematics needs more preparation time from the teacher (R).

R: "[..] Teaching applications of mathematics requires equipment and tools (money) and requires a lot of effort from the teachers in preparing appropriate lessons."

As regarding *teachers' confident in teaching applications of mathematics*, all the teachers reported that they can teach applications of mathematics in other disciplines at a medium to good level, but there are disciplines that are difficult for them and they are not good enough to teach applications of mathematics in them, and they need to prepare more and consult with teachers teaching those disciplines. Three teachers mentioned that they are familiar with applications in Physics.

Re: "I can moderately apply mathematics in other disciplines and especially in physics and in daily life but when it comes to mathematical applications in economics for example, I have to refresh the material and maybe also to learn new topics".

4.2. Case studies of the teachers participating in the intervention

4.2.1. The case of Re

Re loves mathematics and teaching mathematics, because mathematics is important as it can be used and applied in everyday life. She mentioned the following difficulties when teaching mathematics: "the heterogeneity of the study group, the perception among students that the subject is difficult, frightening, and frustrating, and the lack of motivation of the students". Re considered that her strength in teaching mathematics is "developing the inclusion capacity of struggling students and addressing outstanding students; and providing many opportunities for success".

Re considered teaching applications of mathematics important even before the intervention, because “student feels the importance of mathematics, sees its beauty, see that mathematics is more interesting”. Re taught occasionally applications of mathematics even before the intervention.

“I show to the students how mathematics helps them in other disciplines and explains the importance of mathematics as in physics and daily life, as in the field of construction [...] or bank.”

Her confidence in teaching applications of mathematics increased from the pre-intervention interview to the post-intervention interview. She pointed out the importance of the knowledge from disciplines in which mathematics is applied. In her opinion the teacher should have control over the other disciplines also in order to be able to explain the application of the mathematical knowledge in those disciplines. It is also interesting to compare Re’s answers related with her confidence of teaching applications of mathematics given at the three interviews: pre-intervention, during the intervention, and post-intervention. Her opinion didn’t change, but the answers become more and more detailed, the participation in the research as teacher in the experimental class helped her with self-evaluation of her competencies and a deeper understanding of the knowledge required for other disciplines. Her answer at the post-intervention interview is the following:

“It is important for me to have full knowledge and control over the study topics that I teach in class. When I teach applications of mathematics in other disciplines, it is important for me to have full knowledge and full control of these other disciplines as well in order to be a machine and to teach well and I will be confident in the material in which I apply mathematics. But I have not mastered all the other disciplines of science. For example, in order to teach applications of mathematics in the construction domain, I consulted and enlisted the help of a construction engineer. It will also be difficult for me, for example, to teach applications of mathematics in biology. It takes me time, effort and investment to prepare for such classes and it comes at the expense of the study material and the time according to the curriculum towards the matriculation exam.”

Regarding the benefits of teaching applications of mathematics, she considered even at the pre-intervention interview that students’ interest and motivation for learning would increase. Her opinion changed into better with the intervention, at the post-intervention interview she mentioned the following benefits:

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“Great interest of the students and raising motivation for learning among the students. Students love mathematics, study with pleasure and fun, students connect math to everyday life and other disciplines of science and finally I see a significant improvement in student achievement”.

Students in Re’s class received very well the learning of applications of mathematics:

“The students are interested, happy to learn applications of mathematics. For example, students who have difficulty in mathematics, connect very much to the lessons. In particular, when I apply the subject of trigonometry to everyday life, like the subject of construction, students are more interested and see that it matters what they study. as well as understanding why we need math in everyday life. In addition, the motivation of the students increases, they enjoy learning and there is a noticeable improvement in the achievements and grades of the students”.

As regards the obstacles of teaching applications of mathematics, seems, that the time constraint is the most important one, it is mentioned by Re in all three interviews. At the pre-intervention interview she considered important obstacles the “difficulty in adapting relevant applications to the students according to their level of learning” and “insufficient training and knowledge of teachers in other disciplines to apply mathematics in these fields”. It is interesting, that after starting the experiment these two obstacles are not mentioned in the other two interviews. But the worries related with time and curriculum containers are more detailed, the worry not to properly prepare students to matriculation exam seems to be the main obstacle in teaching applications of mathematics:

“The main problem is lack of time and worry about not providing the material, so we have an annual curriculum and need to suffice the material for the matriculation exam at the end of the year, i.e., there is not enough time to teach applications of mathematics in other disciplines.

In the post-intervention interview an additional obstacle is given by Re: students’ knowledge in the disciplines in which the application of mathematics is presented. This shows that students had difficulties regarding some of the applications presented during intervention. These difficulties are presented by Re in the following way:

“There are many difficulties for the students in teaching applications of mathematics, like difficulty in transitioning from verbal language to mathematical language and especially in word problems, as well as difficulty in understanding the other disciplines in which we need to apply mathematics like physics for example. In addition, if the teacher gives the students a task or self-task, they have difficulty connecting mathematics to other disciplines or have difficulty applying mathematics to other disciplines on their own, but when the teacher does this in class they understand and enjoy”.

4.2.2. The case of E

E loves mathematics because it “is interesting, challenging, and fascinating”. In her view, “mathematics is important for understanding the world, math teaches us to think, it gives tools for solving problems in daily life”. She also likes teaching mathematics because she considers it fun and challenging. It is not easy to teach mathematics because of the lack of motivation of the students and their difficulties in understanding mathematics. She is a teacher who is preoccupied about students’ success in mathematics, trying to show the students the utility of mathematics in everyday life and its beauty. E also tries to encourage and motivate struggling students by giving them tasks with progressively increasing difficulty in order to give them the opportunity to feel the success. She considers the personal relationship with the students important.

“I always make sure that my personal relationship with the students is good. I love my students and give them the maximum possible. I believe that every student can succeed. I always encourage them and give them positive reinforcements.”

E considered teaching application of mathematics important even before the intervention. The benefits of teaching applications mentioned by E didn’t change from pre-intervention interview to post-intervention interview, but after the intervention the description of the benefits is more convincing, it is based on the observations during the intervention. The most important benefit is that mathematics becomes more interesting for students. When teaching applications of mathematics “students are more interested and listening in the class, they enjoy learning and learn with more motivation”, because they see its connection with daily life.

“Before I teach applications of mathematics in other disciplines, there were many students who were not interested in mathematics because they thought that mathematics is not related to everyday life and mathematics has no

connection to the other disciplines of science. But after teaching applications of mathematics in the other disciplines and teaching applications in the daily life of the student, this has changed. [...] Students' interest and motivation for learning and their enjoyment of learning increased, and they had better achievements".

The given difficulties of teaching applications of mathematics remain the same on the three interviews: lack of knowledge in the other disciplines, lack of time and the pressure of the matriculation exam. In the post-intervention interview E mentioned that "it is difficult to rely on students to prepare assignments or to study alone applications of mathematics in other disciplines". This shows that the experiment helped E to know better students' knowledge and competencies in the disciplines where applications were taught.

E's confidence for teaching application of mathematics has increased from 7 to 9 on a scale from 1 to 10. She said, that before the intervention she "had mediocre information and ability", but after teaching applications of mathematics in other disciplines and experiencing it, she "already see herself mastering very well and can successfully teach applications of mathematics in other disciplines" because she has already gained some experience.

Conclusions

The main conclusion that can be drawn is that teaching applications of mathematics in other disciplines has a positive effect on teachers.

Before the intervention the teachers used to teach according to the standard methods for the matriculation exams and they were constantly under pressure in order to finish the material and to get the students ready for the exams. Most of the teachers didn't teach applications of mathematics and those who did, they taught applications of mathematics infrequently and not sequentially. Besides, the teachers were not qualified enough to teach applications of mathematics and were not aware of the advantages of teaching applications of mathematics on students and on their own professional development.

However, after the intervention an important change was noticed in teachers' attitudes and teaching. The teachers became well qualified and were able to teach applications of mathematics since they were exposed to the strategy of "teaching applications of mathematics in other disciplines". Indeed, they acquired knowledge and became skilled and competent in teaching applications of mathematics. Furthermore, their level of confidence to teach applications increased significantly (increased from 7 to 9 on a scale from 1 to 10).

The results confirm that the intervention helped the teachers to teach the applications of mathematics with great success and total self-confidence. Participating teachers reported that the intervention had a great effect on the students as well: The students showed a great interest and a desire to learn mathematics.

Overall, the results demonstrate the improvement of the teachers' attitude towards teaching applications of mathematics. Finally, despite the difficulties and the obstacles in teaching applications of mathematics in other disciplines, the teachers reported that they would adopt the method "teaching applications mathematics in other disciplines" in all the classes that they teach and would recommend the method to their fellow teachers.

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APPENDIX

Pre-intervention interview questions

- Q1- Tell me about yourself, about your academic and professional background.*
- Q2-Tell me about the school and the classes that you teach.*
- Q3- What do you think about the profession of teaching mathematics (your opinion)?*
- Q4-Tell me why it is important to teach math?*
- Q5-What are the obstacles and difficulties in teaching mathematics?*
- Q6-What are the benefits of teaching mathematics?*
- Q7-What are the threats you fear in teaching math?*
- Q8-How can you improve your mathematics teaching?*
- Q9-Mathematics is a difficult subject that many students face. How do you deal with this problem? What techniques and strategies do you use with struggling students?*
- Q10-How do you make teaching mathematics an attractive and enjoyable Subject?*
- Q11-What are your strengths / weaknesses as a mathematics teacher?*
- Q12- What do you think about teaching applications of mathematics in other disciplines? Is it important and helpful or not? Explain your answer!*
- Q13-Do you teach applications of mathematics in other disciplines? If Yes, in which disciplines? and if No, why?*
- Q14-In your opinion is there a difference between lessons that you teach applications of mathematics in other disciplines and lessons that you don't teach applications of mathematics in other disciplines? --- In your opinion what are the differences?*
- Q15-What are the benefits and what are the obstacles of teaching applications of mathematics in other disciplines?*
- Q16-How confident are you in your capability for successfully teaching applications of mathematics?*

Interview questions during and after intervention

- Q1: What benefits do you observe when teaching applications of mathematics?*
- Q2: What difficulties do you face when teaching applications of mathematics?*
- Q3: How do students receive applications of mathematics?*
- Q4: What difficulties do students face when teaching applications of mathematics?*
- Q5: How confident are you in your capability for successfully teaching applications of mathematics? (on a scale from 1 to 10).*