



Friends' influence on the development of academic values in mathematics: are there differences between female and male dyads?

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Abstract

Based on the social cognitive theory and the emotional contagion theory, this study investigated if friends influence (reinforce or change) the development of academic values (intrinsic value, emotional cost) and if this process differs across same-sex friendship dyads. We drew on data collected in a two-wave longitudinal study in Germany. The final sample was based on 264 stable reciprocated friendship dyads of grades 5 and 7 (148 female dyads and 116 male dyads). Results of actor-partner-interdependence models indicated that friends reinforce each other regarding the intrinsic value and initiate change regarding the emotional cost. Moreover, female and male friendship dyads did not differ in the strength of influence on academic values. Results were discussed in terms of selection and socialization effects regarding friendships.

Keywords Peer influence · Academic values · Mathematics · Same-sex dyads

Introduction

Academic values are important preconditions for learning and achievement (Eccles 2007; Wigfield and Eccles 2000). The present study focused on those academic values that are defined by an emotional reaction: intrinsic value and emotional cost (Gaspard et al. 2014). Empirical research showed positive effects of intrinsic value on learning and achievement (Chen and Stevenson 1995), whereas emotional costs affected learning and achievement negatively (Hill et al. 2016; Ma 1999). Due to the importance of both values and especially the negative consequences of emotional cost, it is critical that research studies have shown

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mostly unfavorable developments of both academic values during adolescence (Frenzel et al. 2010; Hill et al. 2016).

Possible explanations for the unfavorable developments in these academic values can be found in students' social environments, as emphasized by the expectancy-value theory (Eccles 2007; Wigfield and Eccles 2000). In that regard, surprisingly little attention has been paid to friends (e.g., Chow et al. 2018), as compared with the well-known effects of parents (e.g., Eccles 2007; Gniewosz and Noack 2012). Because of the increasing importance of friends during adolescence (Brown and Larson 2009), the present study explored the role of best friends in the development of academic values, drawing on the background of social learning theory (Bandura 1977; Nangle et al. 2010) as well as emotional contagion theory (Hatfield et al. 1994).

There is growing empirical evidence that academic values are organized in a domain-specific manner (Gaspard et al. 2014; Götz et al. 2007). The present study focused on specific academic values in mathematics. Since mathematics is still a gender-stereotyped subject (Nosek et al. 2002) and emotional expressiveness—an important condition for social learning—differs across genders (e.g., Chaplin and Aldao 2013), friendship gender composition might affect the strength of friends' influence on academic values that are defined by an emotional reaction.

Based on a two-wave longitudinal study on early adolescents, this study investigated two research questions: (1) Do best friends influence (reinforce or change) each other in their development of academic values and (2) Does the strength of influence differ between male and female same-sex friendship dyads.

Academic values

In the expectancy-value theory (Eccles 2007; Wigfield and Eccles 2000), emotional reactions can be found in two of four academic values—namely the intrinsic value and emotional cost. By definition, the intrinsic value includes emotional reactions, such as the enjoyment in doing a task. Cost is defined as the negative consequences resulting from doing a task, including subdomains, such as choosing one option over the other, the amount of effort, or negative emotions doing a task (Gaspard et al. 2014, p. 2). The last facet, on which this study focuses, can be defined as cost of failure and goes along with negative emotions, such as embarrassment and anxiety (Barron and Hulleman 2015). While intrinsic value is well investigated regarding their antecedents as well as their consequences for learning and achievement (cf. Wigfield et al. 2009) cost and the subdimension emotional cost, however, were not paid much attention by researchers, yet (Wigfield and Cambria 2010; for a detailed discussion, see Barron and Hulleman 2015).

Empirical research has shown that the domain-specific enjoyment in mathematics decreased over the secondary school years (Frenzel et al. 2010; Reindl et al. 2015). Empirical evidence for the development of emotional cost is rare, but a study focusing anxiety—a construct that is closely related to emotional cost—showed an increase during the secondary school years (Hill et al. 2016). With respect to the domain-specific focus on academic values in this study, the magnitude of the change can vary between different subjects (e.g., Baumert and Köller 1998). Therefore, students can develop their own preferences for specific topics that can also be derived from significant variations in these developmental trajectories in the domain of mathematics (Frenzel et al. 2010; Hill et al. 2016; Reindl et al. 2015).

An important personal factor explaining the variations in the development of domain-specific values in mathematics is the child's gender. Thus, gender role identities can be one explanation for male students perceiving mathematical knowledge as more important than female students subsequently resulting in higher competence beliefs and in turn higher academic value scores as compared with female students (Wigfield and Eccles 1992). Studies showed such gender-specific differences in the mean levels of academic values, such as the intrinsic value and emotional cost indicating that males reported a higher intrinsic value than girls did, whereas girls reported higher emotional cost than boys in mathematics (Gaspard et al. 2014; Frenzel et al. 2007; Hill et al. 2016). These gender differences in the mean level of academic values in mathematics stay quite stable or rather intensify only slightly during adolescence (Frenzel et al. 2007).

Further explanations for the development of academic values might be also found in the students' social environment. Besides the well-known influences of parents (e.g., Gniewosz & Noack 2012) and teachers (e.g., Frenzel et al. 2009), the role of friends was less focused in this regard, although students increasingly adapt their attitudes and behaviors to their friends' attitudes and behaviors during adolescence (Brown and Larson 2009).

Friends' influence on academic values

As adolescents spend plenty of their time in formal classroom settings (OECD, 2013), the best friend within classroom—defined as a voluntary, dyadic, and reciprocal relationship between two individuals (e.g., Hartup 1996)—is considered to be a crucial source of school-related values (e.g., Altermatt and Pomerantz 2003). Especially in sustained friendships, adolescents exchange personal feelings more frequently (Sullivan 1953), resulting in higher levels of intimacy as well as trust, as compared with non-stable friendship dyads (Buhrmester and Furman 1986; Bukowski et al. 1994; Hiatt et al. 2015).

Theoretical concepts acknowledged that friends are quite similar regarding several characteristics (Kandel 1978). Explanations can be found in selection and socialization processes. First, similarity in several characteristics could be a reason for selecting other students as friends (selection), *before* a friendship is established. Second, this similarity could be a result of students' influence on each other over time (socialization), *after* a friendship is established. The present study explicitly focused on the friends' influence on the *development* of academic values (socialization). With respect to intrinsic value, empirical findings support that friends influence each other and therefore getting more similar over time (Chow et al. 2018; Shin and Ryan 2014). For example, Shin and Ryan (2014) analyzed relationships between students' intrinsic values and their best friends' intrinsic values. The results suggest that the friends' intrinsic value influence students' intrinsic values over the course of a single school year. For emotional cost, however, research on best friends' influence is rare.

Two theoretical frameworks constituted the rationale for expecting best friends' influences. First, social cognitive theories (e.g., Bandura 1977; Nangle et al. 2010) argue that the friends' influence on academic values defined by an emotional reaction involves two aspects: (1) the observation of the friend showing the emotional reactions or (2) the communication about emotional reactions (Bandura 1977; Nangle et al. 2010). Second, emotional contagion theory (Hatfield et al. 1994) describes these processes in greater detail and argues that the adoption of emotional values is based on two steps. In a first step, students mimic the emotions of their interacting partners. The probability of mimicking the emotions of another person is higher between best friends than in other social relationships within classroom because the empathy

created by exhibiting the same emotions strengthens higher levels of intimacy. In addition, students can perceive the best friend's emotional verbalizations (cf. Hatfield et al. 1994). There is empirical evidence that information about emotional experiences via verbal expressions, such as "Math is fun", is an important source for perceiving another person's emotions (Wild et al. 1997). The second step explains why individuals actually feel the same way as the interaction partner, the so-called facial feedback hypothesis: the central nervous system is responsible for emotional experiences. Thus, feedback via facial expressions is transmitted to the central nervous system. Consequently, if a person shows his/her emotions through the contraction of muscles (e.g., smiling), the probability is higher that a person experiences the same emotion as his/her counterpart (e.g., Davis et al. 2009).

An important question regarding the friends' influence on the development of academic values is if they reinforce or change those values (Ryan 2000, p. 105). Both possibilities are dependent on the initial similarity of friends. In the case that friends are quite similar in their emotional values, it should be more likely that friends reinforce each other in the way that they stay quite similar in their emotional values over time. But if friends are not similar in their initial values, adolescents might feel pressure to change their characteristics to or simply learn the other person's emotional responses.

Differences between same-sex friendships

In early adolescence, friendship dyads are mostly same-sex dyads (e.g., Clark and Ayers 1992). This implies that gender differences in friendship characteristics concerning the expression of and the communication about emotional reactions may affect the strength of friends' influence. First, within female friendship dyads, the expression of emotions should be more likely than in male friendship dyads. Theoretical assumptions (e.g., Bandura 1969) as well as empirical results (Chaplin and Aldao 2013) indicate that females in general are more expressive in showing their emotions than males. Especially for negative emotions, a study from Chaplin et al. (2005) found that boys with increasing age express lower anxiety than girls during a frustration game. Furthermore, there is empirical evidence showing that female friendship dyads are more intimate in their conversations, whereas male friendship dyads are rather characterized by doing things together (Caldwell and Peplau 1982; Hall 2010). Applied at the social learning theory (Bandura 1977; Nangle et al. 2010) and social contagion theory (Hatfield et al. 1994), the observation of emotional expressions as well as intimate conversations about academic values should be more likely in female friendship dyads, as compared with male friendships dyads. Hence, the opportunities for perceiving the emotional reactions of the counterpart and in turn feeling the same emotion as the counterpart through facial feedbacks should be also more likely in female friendship dyads than in male friendship dyads. Thus, stronger influence effects were expected within female friendship dyads than in male friendship dyads.

The present study

This study, as one of the first, focused on the influence of best friends on the development of academic values, i.e., intrinsic value and emotional cost in mathematics. Based on social learning theory and emotional contagion theory, we expected that best friends influence each other in their development of both academic values. As research has shown, there are some studies showing that friends play an important role for the development of the intrinsic value.

However, for emotional cost—which is also an important precondition for learning and achievement—so far no study has investigated best friends' influences. Therefore, this study will expand the knowledge regarding best friends' influences on intrinsic value *and* emotional cost.

Because friends' influence can be described as reinforcement as well as change processes, we formulated two competitive patterns of hypotheses. Because both processes can be applied for both emotional values (intrinsic value and emotional cost), both patterns can be true.

In case of friends' influence as “reinforcement”, we expected a

H1a: positive and stable similarity over time between friends *as well as* no influence of the best friends' emotional values on the change of adolescents' emotional values.

In case of friends' influence as “change”, we expected an

H1b: increasing similarity between friends' emotional values over time *as well as* a positive influence of the best friends' emotional values on the change of adolescents' emotional values.

Alternatively, in case of no influence within friendship dyads, no similarity at both measurement occasions as well as no influence of the best friends' emotional values on the change of adolescents' emotional values was expected.

As we focused on early adolescence, friendship dyads are mostly same-sex dyads. Therefore, gender differences in regards to the opportunities to observe emotions or to communicate about emotional reactions might affect the dyadic influence. Because of higher levels of emotional expressions as well as of intimate communication about academic values in female friendship dyads than in male friendship dyads, perceiving the values from each other and in turn adopting them is more likely in female friendship dyads than in male friendship dyads. Thus, the conditions for social learning are met to a stronger degree in female friendship dyads. Therefore, we expected that

H2: within female friendship dyads, the effect of friends' influence regarding both academic values is stronger, as compared with male friendship dyads.

This study extends the understanding of friends' influence on the development of academic values in several regards. First, research on emotional cost in the framework of the expectancy \times value theory is rare. Moreover, there has been less research on friendship effects despite the knowledge that friends get important role models during adolescence. Second, the adolescents' as well as the best friends' academic values were measured as self-reports. Thus, the inflated within-friendship-dyad similarity due to adolescents projecting their own values onto their friends (Ryan 2000) could be prevented. Third, a lot of research relied on cross-sectional associations within dyads (Reindl et al. 2018). But for the investigation of friends' influence on the development of academic values, a longitudinal design is needed. Therefore, this study drew on a longitudinal design with two time points within one school year. Finally, as friendship characteristics differ across same-sex friendship dyads, we are one of the first studies investigating gender differences with regard to dyadic' influences on the development of academic values in mathematics between best friends.

Methods

Participants

This study was based on data collected in a larger German longitudinal study with two measurement points. At the first time point, the participants ($N = 804$) attended grades 5 and

7 in public secondary schools. The measurement occasions were scheduled at the beginning of the school year (time 1) and at the middle of the school year (time 2, approximately 4-month time gap). To test the hypotheses, we chose only those students who took part in both measurement points (81% of the participants) and reported stable reciprocated same-sex friendships ($n = 382$ dyads). The percentage of stable and reciprocated friendships in relation to reciprocated friendships at time point 1 was 71% ($n_{t1} = 531$). For students, who had more than one reciprocated friendship, we chose the highest ranked reciprocated friendship dyad. Thus, the final sample consisted of 148 female dyads and 116 male dyads; mean age = 11.95; $SD = 1.17$ from 38 classrooms. In this sample, 147 dyads of the students attended a higher school track and 117 dyads the lower school tracks.¹ The study was approved by the Kultusministerium of Baden-Württemberg (Department of Educational and Cultural Affairs of the State Government). Ethical protocols were followed including the assurance of anonymity, confidentiality, and voluntariness. Informed consent for participating in the study was given by the principals of the schools, the teachers, the parents, as well as the students. The data collection was conducted by trained research assistants.

Measures

Friendship dyads Friendship dyads were identified through peer nominations (Bukowski et al., 1994). Adolescents nominated three best friends at the same classroom. Adolescents and their best friend were matched within the data set through the unique identification number. Stable reciprocated friendships were identified through a repeated nomination at time 2, independent of the nominated rank.

Academic values Intrinsic value was assessed by a standardized German questionnaire (SESSW, Steinmayr and Spinath 2010) including three items (e.g., “Mathematics is fun to me”). Emotional cost was assessed by a German subscale of a questionnaire by Gaspard et al. (2014) including four items (e.g., “Math is a real burden to me”). Because this study was part of a larger study on motivation and peers, we applied a multi-matrix design (Jorgensen et al. 2014) with three test booklets in which a balanced approach over time was used. Test booklets were randomly distributed within each classroom. This method provides results similar to those obtained with complete datasets (Smits and Vorst 2007). All items were rated on a five-point scale, ranging from 1 (*completely not true*) to 5 (*completely true*). Construct reliabilities regarding the indices for the adolescents as well as the best friends can be taken from Table 1.

Analyses

All models were estimated using MPlus 8 (Muthén and Muthén 2017). The multi-matrix design necessitates the application of a MAR assumption regarding missing values controlled by the researcher. Missing values by item non-response proved to be completely at random, Little’s MCAR test: $\chi^2 (115, n = 264) = 107.72, p = .672$. Thus, we were able to use an MLR estimator that is comparable with the full information

¹ The German school system consists of several tracks for secondary education. Students are assigned to one of three major school tracks according to ability. These are one higher, college-bound school track (Gymnasium) and two more vocationally oriented lower school tracks (Realschule and Gesamtschule).

Table 1 Summary statistics (latent level)

	<i>M</i>	<i>SD</i>	1.	2.	3.	4.	5.	6.	7.	8.
1. Intrinsic value adolescent T1	3.33	1.16	(.93)							
2. Intrinsic value friend T1	3.33	1.16	.27*	(.93)						
3. Emotional cost adolescent T1	2.15	0.78	-.70**	.00	(.67)					
4. Emotional cost friend T1	2.15	0.78	-.12	-.74**	.10	(.67)				
5. Intrinsic value adolescent T2	3.32	1.15	.76**	.22*	-.61**	-.14	(.94)			
6. Intrinsic value friend T2	3.32	1.15	.25**	.79**	-.01	-.60**	.23**	(.94)		
7. Emotional cost adolescent T2	2.14	0.97	-.61**	-.11	.73**	.23*	-.59**	-.13	(.80)	
8. Emotional cost friend T2	2.14	0.97	-.20*	-.58**	.18*	.81**	-.20*	-.62**	.24**	(.80)

Correlations represent intra-class correlations. The values in the diagonal represent the construct reliability (Jöreskog's rho)

* $p < .05$, ** $p < .01$

maximum likelihood estimator. Thus, all model parameters were estimated based on the available data, resulting in reduced biased results compared with list-wise deletion techniques (e.g., Arbuckle 1996). The data were collected within classroom; thus, the data structure is nested. This leads to a violation of the independence of observation assumption for standard SEM. Ignoring the nested data structure would lead to biased estimations of the standard errors (Raudenbush and Bryk 2002). Therefore, the pseudo maximum likelihood estimator (PML, Asparouhov and Muthén 2005) was engaged to correct for the effects of observation dependencies within classrooms.

The three items of intrinsic value served as manifest indicators for the latent constructs. Regarding the construct emotional cost, two item parcels were constructed using the item-to-construct balance approach (Little et al. 2002). Items with high and low factor loadings regarding one latent state construct were distributed equally among parcels in order to maximize the between-parcel covariances. Due to the relatively small sample size, we chose this approach.

To exploit the full potential of the longitudinal data set, true intraindividual change (TIC) models (Steyer et al. 2000) as actor-partner-interdependence models (APIM) for interchangeable dyads (Olsen and Kenny 2006) were applied to model changes in the variables of interest and predict them through the dyad members, controlled for gender effects. One prerequisite for interpreting the results of change models are invariant constructs across measurement occasions (Schmitt et al. 2011). Therefore, the dimensions of intrinsic value and emotional cost were first tested for their time invariance along three steps (Cheung and Rensvold 2002). The first step tested the configural invariance. Here, the constructs were modeled as described above, following theoretical considerations. This model showed a good fit, $\chi^2(24, n = 264) = 37.06, p = .043, RMSEA = .05, SRMR = .03, CFI = .99, TLI = .98$, indicating configural invariance. The second step, metric invariance over time, was tested by restricting the factor loadings to be equal across time points. The comparison between the configural and the metric

model showed no systematic difference, TRd^2 ($df=3$) = 7.43, $p = .059$, indicating metric invariance. In the third step, scalar invariance was tested by fixing the manifest intercepts to be equal between time points additional to the fixed factor loadings. As compared with the metric model, these restrictions did not lead to a worse model fit, TRd ($df=3$) = 3.07, $p = .380$, which points to scalar invariance. Thus, the requirements of invariant constructs across measurement occasions were met.

Following the suggestions by Olsen and Kenny (2006), we implemented several restrictions regarding the measurement model for the latent specification of the academic values as well as the specification of the paths in the APIM. Preventing an overestimation of the assumed associations within indistinguishable dyads (the student is a best friend at the same time) for intrinsic value the factor loadings (a , b), the item intercepts (c , d , e), and the measurement error variances (f , g , h), the mean (t , r), and the variances (s , u) of the intercept and change variables were set to be equal. Because the latent variables for emotional cost were specified with two item parcels, one factor loading (a), two item intercepts (c , d), and two measurement error variances (f , g) were set to be equal (see Fig. 1).

Regarding the true intraindividual change (TIC) model, an intercept depicting the adolescent T1 value on the respective variable and a change variable were specified. This is modeled by predicting all manifest indicators regarding one construct by a latent intercept (T1 variable) and by a change variable. Those change variables measure the intraindividual changes relative to the baseline. Regarding all constructs, the covariances between intercept and change variables within the person (v) were estimated and set to be equal. These covariances represent the actor effects, e.g., the effect of the friend's academic value on his/her own development of academic values as well as the effect of the student's academic values on his/her own development of academic value.³

Testing our competitive hypotheses regarding friends' influence on the development of academic values (H_{1a} and H_{1b}), we followed two steps. First, we calculated latent intra-class correlations at the two time-points for both academic values. In a second step, the partner effects were estimated and according to the suggestions from Olsen and Kenny (2006) for indistinguishable dyads set to be equal. The partner effects imply the effect of the friend's emotional value on the student's change of academic values, and the effect of the student's emotional value on his/her friend's change of academic value (see Fig. 2). In summary, stable, significant intra-class correlations at both time points as well as non-significant partner effects on the change of emotional values might confirm the reinforcement hypothesis (H_{1a}). Increasing significant intra-class correlations over time as well as significant partner effects on the change of emotional values might confirm the change hypothesis (H_{1b}). Because it was possible that one student was nominated more than once as best friend, a weighting option was used pending on the number of nominations (Olsen and Kenny 2006).

Testing the moderation by gender, multi-group models were estimated (male vs. female friendship dyads). In the first model, the regression weights were estimated separately in both groups. In a second model, these regression weights were set to be equal across groups. If this restriction leads to a worse model fit as compared with the first unrestricted model, a

² Differences in the model fits cannot be determined by conventional χ^2 -difference tests because the fit statistics obtained by the MLR-estimator in Mplus are based on a scaled χ^2 . Therefore, scaled χ^2 difference test statistics (TRd) were applied (Satorra, 2000; Satorra & Bentler, 2001).

³ The calculated models are the I-SAT-Models described by Olsen & Kenny (2006) resulting in no further adjustments to the chi-square test statistic and model fit indices.

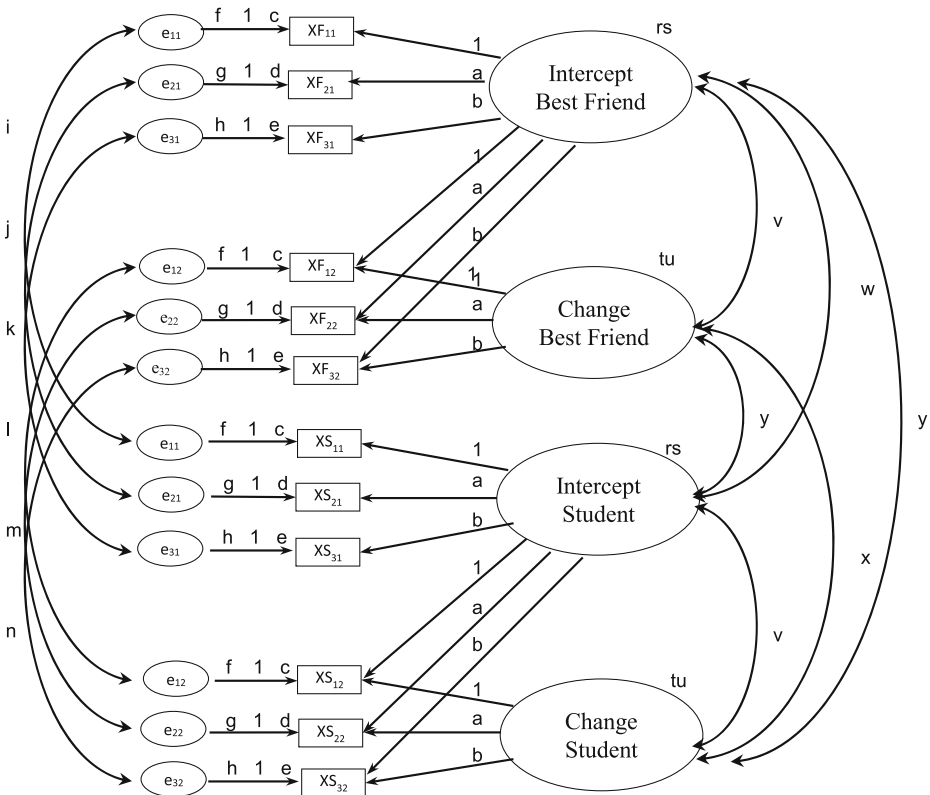


Fig. 1 The actor-partner-interdependence model as change model with latent intercept and change variables of emotional values (based on Olsen & Kenny 2006). The parameters for the latent measurement model of the intrinsic value variables include two estimated factor loadings for time 1 and time 2 (a and b), the three item intercepts (c , d , and e), the three item measurement error variances (f , g , and h), and the three item intra-class error covariances (i , j , k , l , m , and o), the intercept factor mean (r), the intercept factor variance (s), the change factor mean (t), the change factor variance (u), the covariances between intercept and change factors within the person (v , actor effects), the covariance between intercepts (w), the residual covariance of change factors (x), the covariances between intercept and slopes across the person (y , partner effects). The parameters for the latent measurement model of the emotional cost variables include one estimated factor loadings for time 1 and time 2 (a), the two item intercepts (c , d), the two item measurement error variances (f , g), and the two item intra-class error covariances (i , j , l , m). Identical labels are set to be equal

moderating effect through gender can be assumed. A requirement for multi-group models is invariant constructs across groups. Therefore, we tested the invariance across gender groups along three steps (Cheung and Rensvold 2002) as described above for testing invariance across measurement occasions. The first model showed a satisfactory fit, $\chi^2(60, n = 264) = 106.61$, $p = .00$, RMSEA = .08, SRMR = .06, CFI = .96, TLI = .93, indicating configural invariance. The comparison between the configural and the metric model showed no systematic difference, $TRd(df = 3) = 2.32$, $p = .508$, indicating metric invariance. As compared with the metric model, the restrictions in the scalar model did not lead to a worse model fit, $TRd(df = 3) = 1.72$, $p = .634$, which points to scalar invariance. Thus, the requirements of invariant constructs across groups were also met.

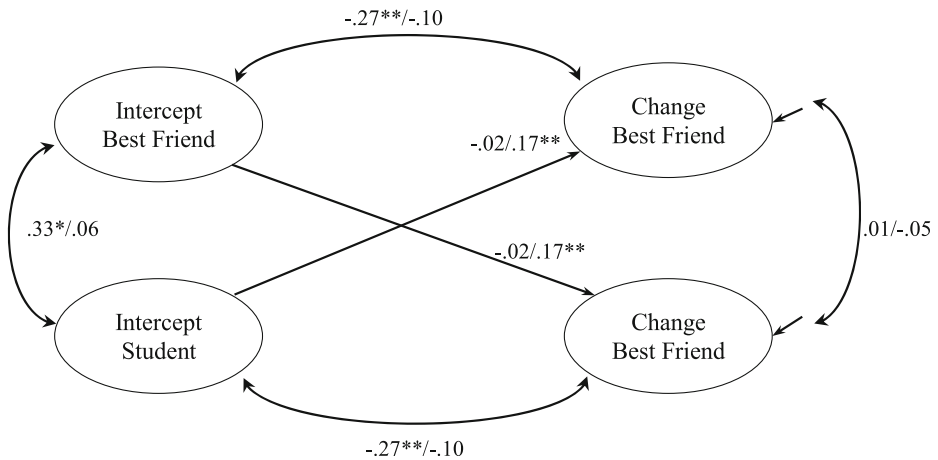


Fig. 2 Final structural equation model; coefficients (intrinsic value/emotional cost) represent unstandardized estimates

Results

Descriptive results

In a first step, change models without predictors were specified. Both models showed a good fit, intrinsic value: $\chi^2(61, n = 264) = 53.27, p = .749, RMSEA = .00, SRMR = .04, CFI = 1.00, TLI = 1.00$, emotional cost: $\chi^2(23, n = 264) = 28.73, p = .190, RMSEA = .03, SRMR = .05, CFI = .99, TLI = .98$. On the mean level, no significant changes were found for intrinsic value as well as emotional cost for the adolescent as well as the friend (see Table 2). However, the standard deviations (SD) of the changes differed significantly from zero, for boys as well as for girls. Thus, these substantial variations can be explained by the predictor variables of interest. A first look at the correlations provided insights into the assumed relationships (see Table 1).

Friends' influence on academic values

The final model for intrinsic values fitted the data well, $\chi^2(71, n = 264) = 69.90, p = .515, RMSEA = .00, SRMR = .05, CFI = 1.00, TLI = 1.00$. Consistent with our reinforcement hypothesis (H_{1a}), the best friend's intrinsic value did not predict the change in adolescents' intrinsic value over time, $\beta = -.02, SE = .05, p = .661$, indicating that friends do not affect each other regarding their change of intrinsic values in mathematics. Furthermore, friends' intrinsic values correlated significant at both time points, indicating that friends stay similar over time (Table 1).

The final model for emotional cost fitted also the data well, $\chi^2(28, n = 264) = 32.51, p = .254, RMSEA = .025, SRMR = .05, CFI = .99, TLI = .99$. Supporting the change hypothesis (H_{1b}), the emotional cost of the friend at time point 1 significantly predicted the change in the emotional cost of the friend, $\beta = .17, SE = .06, p = .005$, indicating that a high level of a student's emotional cost goes along with increases in the emotional cost in his/her friend and vice versa. Moreover, emotional cost correlated only significant at time point two between friends indicating an increased similarity between friends (see Table 1). The results for change

Table 2 Summary statistics for latent intercepts and changes

	Intrinsic value			Emotional cost		
	All	Girls	Boys	All	Girls	Boys
Intercept						
<i>M</i>	3.35**	2.96**	3.28**	2.14**	2.16**	2.09**
SD	1.16**	1.07**	1.04**	0.77**	0.78**	0.65**
Change						
<i>M</i>	-0.05	0.00	-0.08	0.00	-0.05	0.07
SD	0.79**	0.84**	0.59**	0.60**	0.59**	0.53*

* $p < .05$, ** $p < .01$

effects are also depicted in Fig. 2. Gender did not significantly predict the development of intrinsic value, $\beta = .17$, $SE = .12$, $p = .143$, or emotional cost, $\beta = -.16$, $SE = .11$, $p = .145$.

Moderation by same-sex friendships

Addressing the moderation hypothesis, we specified multi-group models. The model for intrinsic value fitted satisfactory to the data, $\chi^2 (130, n = 264) = 205.95$, $p = .00$, $RMSEA = .07$, $SRMR = .08$, $CFI = .93$, $TLI = .93$. Furthermore, the restricted model did not differ significantly from the unrestricted model, $TRd (df = 1) = 0.34$, $p = .557$, indicating that the friends' influence on intrinsic value did not differ across the friendship dyads, male: $\beta = .02$, $SE = .07$, $p = .731$, female: $\beta = -.04$, $SE = .08$, $p = .636$. Also, the second multi-group model for emotional cost fitted the data well, $\chi^2 (50, n = 264) = 46.40$, $p = .619$, $RMSEA = .00$, $SRMR = .07$, $CFI = 1.00$, $TLI = 1.00$. Again, the difference between the unrestricted and the restricted model was not significant, $TRd (df = 1) = 0.28$, $p = .595$. However, there was a significant effect within the female friendship dyads, female: $\beta = .20$, $SE = .10$, $p = .038$, but not in the male friendship dyad, $\beta = .11$, $SE = .12$, $p = .347$, pointing to small differences in the friends' influence between dyads.

Discussion

Based on the social learning theory (Bandura 1977; Nangle et al. 2010) and the emotional contagion theory (Hatfield et al. 1994), this study investigated socialization effects in friendship dyads of academic values regarding intrinsic value and emotional cost in mathematics in early adolescence. Our hypotheses regarding friends' influence of academic values in terms of reinforcement (H_{1a}) as well as change (H_{1b}) mechanisms in friendship dyads were both supported. Thus, the friends' influence on the development of academic values is not a uniform process.

For intrinsic value, we found stable, statistically significant correlations between friends at both time points (T1: $r = .27^*$, T2: $r = .23^{**}$) and non-significant effects on the change of intrinsic value. This pattern indicates that for intrinsic value, "reinforcement" describes the appropriate influence process within friendship dyads (Ryan 2000). Friends seem to reinforce students' intrinsic values over time, i.e., friends stay quite similar over time on the same level. In contrast to these results, some longitudinal studies found significant, but small effects of peer group characteristics on changes in adolescents' intrinsic value (Kindermann 2007; Ryan

2001). Perhaps students are more focused on larger peer groups, as compared with friendship dyads, for changing their intrinsic value and therefore fulfilling their social norms and, in turn, stay part of the group. The result pattern in the present study for intrinsic values may also be explained by the literature on selection vs. socialization processes within friendship dyads (Kandel 1978). It might also be possible that the initial similarity in intrinsic value is a precondition to select a person as a friend and creating a reciprocated friendship, e.g., students pick students as friends based on similar values. To test this selection vs. socialization hypothesis, future studies including at least three time points are necessary. If students select friends between time point 1 and time point 2, socialization effects (reinforcement vs. change) can subsequently be tested between time point 2 and time point 3.

For emotional cost, however, the friends' effects on the changes over time were found. Thus, the increased within-friendship similarity (T1: $r = .10$, T2: $r = .24^{**}$) can rather be explained by friend's influences than by selection processes, because there was a low similarity at time point 1. Furthermore, the effect over time supports the "change" interpretation of within friendship dyad socialization (Ryan 2000). The reason for the differences between outcomes could be that emotional cost, for instance anxiety, is rather private in nature and, therefore, not deliberately shared. Moreover, there is also empirical evidence that persons mask their negative emotions in less intimate relationships, e.g., in non-friendship peer groups (Zeman and Garber 1996). Therefore, emotional cost should be harder to observe outside friendship dyads. It is, in turn, harder to use as information for selecting a person as a friend. However, as a friendship grows more intimate, it becomes more likely that students openly express their emotions. Thus, the expression of positive (intrinsic value) and negative (emotional cost) emotional reactions should be the same *within* best friendships. However, the intensity how much attention students spend on the emotional reactions of their best friends might differ as well. Generally, people pay more attention to negative emotional reactions than positive emotional reactions (Eastwood et al. 2001). Therefore, perceiving negative emotional reactions and in turn adopting them should be more likely than for positive emotional reactions within a friendship. Both mechanisms, visibility of and attention for positive vs. negative emotions, might explain the difference in friends' influence regarding emotional cost and intrinsic value.

Taken together, *before a friendship* is established, the intrinsic value might be a selection factor because of a better visibility than emotional cost. Therefore, *within a friendship*, "reinforcement" as subsequent mechanism of influence for the intrinsic value is more likely because both students enter the friendship on a higher initial similarity level. For emotional cost "change" as socialization mechanism is more likely. *Within a friendship*, the visibility and especially the attention for negative emotional reactions are higher than for positive emotional reactions.

Finally, these effects were not significantly moderated by gender, although regarding emotional cost, statistically significant effects were found in female but not in male friendship dyads. This could tentatively be regarded as some support for our assumption that within female friendship dyads, the expression of emotions (Chaplin and Aldao 2013) as well as the communication about it (Caldwell and Peplau 1982; Hall 2010) and subsequently the socialization "change" effects should be more likely than in male friendship dyads. However, the effect sizes were basically the same for boys and girls. This could mean that in male friendship dyads, there is more heterogeneity in the statistical effects as well as in the expression, communication, and therefore the friends' influence on the development of emotional cost. In detail, some boys might not have the pressure to fulfill stereotyped expectations within an intimate relationship like a friendship, e.g., that they have no fear of math (Chaplin and Aldao 2013). Therefore, future studies might focus on potential subgroups within male-friendship dyads.

With respect to the theoretical rationales of our study, we assume that change as well as reinforcement effects can be explained by social learning theory (Bandura 1977; Nangle et al. 2010) as well as emotional contagion theory (Hatfield et al. 1994). In detail, emotional values might be learned or be stabilized through observational and communicational processes within friendship dyads over time. But with regard to the reinforcement mechanism, social comparison theory (Festinger 1954) provides an additional explanation why best friends' similarity remains at the same level over time. Individuals generally seek support of their own behaviors and beliefs in terms of a self-validation. Thus, students seem to compare their own intrinsic values with the intrinsic values of their friends. If friends perceive themselves as similar, the motive for self-verification is supported. Hence, the perceived coherence between friends might result in the reinforcement for the own intrinsic value (Swann and Buhrmester 2012). Moreover, based on the perceived stable similarity, a deselection process, i.e., a friend deselects another person as his/her friend becomes less likely. But surely, these post hoc interpretations of the mechanisms have to be investigated more directly in future research.

There are some limitations of the study. First, the subsamples of female and male friendship dyads were quite small. It would be good to replicate our result pattern with larger samples. Second, this study investigated adolescents attending the fifth and seventh grades. Future studies should also focus on older adolescents to investigate changes in dyadic influences between friends during adolescence. Third, although the first measurement occasion took place in the beginning of the school year, we have to keep in mind that best friends could have influenced each other earlier and the similarity at time point 1 is in turn a result of a change effect through friends that is out of ones' focus. Fourth, results are limited to the educational system of Germany. In Germany, students spend most of their time learning in a stable classroom community, and therefore have more opportunities to adjust to their classmates and therefore increasing the likelihood of dyadic influences. Finally, our data does not allow for distinguishing between (a) reinforcement effects in friendship dyads, as in intrinsic values, and (b) selection effects based on the outcome measures and socialization effects in these dyads afterwards. For testing both options, more measurement occasions are necessary to investigating if the within-person stability in the outcomes may increase due to reinforcement processes. If the stability measures do not change, reinforcement effects are less likely.

Conclusion

Based on our results, this study suggests that friends influence each other in regards to their intrinsic value as well as in emotional cost. For intrinsic value, friends rather seem to reinforce each other and stay similar over time. With respect to emotional cost, friends seem to rather trigger a change resulting in an increased similarity over time. Furthermore, we found no clear gender-composition differences in friends' influence on the development of emotional values in mathematics. In sum, it seems reasonable to assume that friends can facilitate students' levels of academic values—independent of gender-specific compositions.

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- *Reindl, M., Tulis, M., & Dresel, M. (2018). Associations between friends, academic emotions and achievement: Individual differences in enjoyment and boredom. *Learning and Individual Differences*, 62, 164-173.
- Reindl, M., Gniewosz, B., & Reinders, H. (2016). Socialization of emotion regulation strategies through friends. *Journal of Adolescence*, 49, 146-157.
- *Reindl, M., Berner, V., Scheunpflug, A., Zeinz, H., & Dresel, M. (2015). Effect of negative peer climate on the development of autonomous motivation in Mathematics. *Learning and Individual Differences*, 38, 68-75.
- Burkhard Gniewosz, Department of Educational Science, University of Salzburg, Austria

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- *Gniewosz, B., & Noack, P. (2012). What you see is what you get: The role of early adolescents' perceptions in the intergenerational transmission of academic values. *Contemporary Educational Psychology*, 37(1), 70-79.
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- Daumiller, M., Dickhäuser, O., & Dresel, M. (2019). University instructors' achievement goals for teaching. *Journal of Educational Psychology*, 111, 131-148.
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