Intrinsic Motivation as a Key to School Success: Predictive Power of Self-perceived Autonomy, Competence and Relatedness on the Achievement in International Comparative Studies

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When addressing the possible predictors of academic achievement in various domains, one firstly comes across the concept of motivation. For instance, one of the frequently asked questions is: How to motivate students to learn more, to achieve more and to have higher conceptual knowledge. One of the most empirically supported theories of contemporary psychology of motivation is Self-Determination Theory (SDT) (Ryan & Deci, 2002). SDT was chosen as a framework of present paper due to its in-depth model of intrinsic and extrinsic motivation with practical implications also for the field of education.

SDT Theory

SDT focuses on the quality of motivation and not so much on the quantity of motivation. SDT theory differentiates amotivation, controlled (extrinsic) motivation and autonomous (intrinsic) motivation. Amotivation is defined as a total lack of motivation. Intrinsic motivation is the inherent propensity to seek out novelty and challenge, to extend and exercise ones capacities, to explore and to learn (Reeve, 2015). On the other side, extrinsic motivation arises from environmental incentives (rewards, consequences, punishments) that are separate from activity itself (Reeve, 2015). All three types of motivation can be placed on the continuum of perceived locus of control or self-determination. The type of motivation is closely linked to the perceptions that individuals have on the origins of their behaviour (whether they are inside or outside of their control). On one end of the continuum is amotivation (a total lack of intentionality and motivation). In the continuum, amotivation is followed by four types of extrinsic motivation that can be distinguished be-

tween one another depending on the degree of autonomy: external regulation (not at all autonomous), introjected regulation (somewhat autonomous), identified regulation (mostly autonomous) and integrated regulation (fully autonomous). On the other end of the continuum is intrinsic motivation as the highest level of self-determination (Ryan & Deci, 2000). One of the many advantages and practical implications of SDT is that it explains how amotivation can be changed to extrinsic motivation (in the process of internalization) first using external regulation (the task is done in order to obtain rewards or avoid negative consequences), then introjected regulation (the task is done in order to improve self-esteem and avoid shame, guilt and anxiety) to identified regulation (the task is done because students feel it is important and related to their personal goals - they consciously apply value to it) and finally to integrated regulation (the task is done because it represents an integral part of values and needs of student). The level of self-determination, perceived autonomy, increases as we move on through the continuum. The building stone of the change form external to internal motivations is fulfilment of three basic psychological needs: autonomy, competence and relatedness.

SDT in Educational Setting

Two decades of research in the educational setting provided empirical support for this conclusion: intrinsically (autonomously) motivated students thrive in educational setting (Reeve, 2002; Miserandino, 1996; Flink et al., 1992). Students who have high levels of intrinsic motivation have higher academic achievement and more conceptual knowledge (Guay & Vallerand, 1997; Hardre and Reeve, 2003). Research showed that low achieving students typically have lower levels of intrinsic motivation and identified regulation and higher levels of amotivation (Legault, Green-Demers, & Pelletier, 2006). The mechanisms linking intrinsic motivation and academic achievement are: engagement and effort. When students are intrinsically motivated they experience engagement. The higher a person's intrinsic motivation the greater will be his or her engagement in task (e.g. school tasks in school setting), effort to pursuit their goals (Sheldon & Elliot, 1999) and focused attention in class (Hardre & Reeve, 2003; Skinner & Belmont, 1993) which is all related to higher academic achievement. Students that are intrinsically motivated perceive their school-related tasks as decided by themselves (self-determined) and based on their personal values and interests (Alivernini & Lucidi, 2011). On the other side, the problem with extrinsic motivations is that when these environmental incentives are withdrawn the behavior stops as well – for instance if student is externally motivated to be in school (e.g. grades, parental pressure)

and if these external rewards or punishers are gone (or student no longer finds them relevant), the student will become less engaged which leads to lower academic achievement and perhaps even early school leaving. All this support the notion that it is crucial to support students' intrinsic motivation in order to see students succeed in school and in later life.

According to the SDT framework, the type of motivation depends on the fulfilment of three basic psychological needs: need for autonomy, need for competence and need for relatedness. People are naturally intrinsically motivated to learn and in a supporting environment all three basic needs are met and learning is intrinsically motivated and of a higher quality. The need for autonomy refers to being the perceived origin or source of one's own behaviour (Deci & Ryan, 2002). The need for competence refers to feeling effective in one's ongoing interactions with the social environment and experiencing opportunities to exercise and express ones capacities (Deci & Ryan, 2002). The need for relatedness refers to feeling connected to others, to caring for and being cared for by others, to having a sense of belonging both with other individuals and with one's community (Ryan, 1995). Students become more intrinsically motivated when their basic psychological needs of autonomy, competence and relatedness are fulfilled. The need for competence and autonomy are the most important ones in the development of intrinsic motivation whereas the need to relatedness is crucial when transforming external regulation to autonomous regulation and supporting the process of internalization (Deci & Ryan, 2002). Legault and colleagues (Legault et al., 2006) found that the lack of support for the three needs contributed to amotivation (a total lack of motivation or the lowest level of self-determination). Students that are amotivated do not want to study and they feel they cannot change their academic outcomes and the most likely consequence of those feelings is that these students would leave their schooling as soon as they can. Experimental work shows when students are tested or given rewards for activities that for them are intrinsically motivated, their intrinsic motivation decreases due to lowering their sense of autonomy. In contrast, providing students with choice (thus supporting autonomy) and positive feedback (thus supporting competence) typically increases intrinsic motivation. The satisfaction of all three needs results in strong intrinsic goals (e.g. personal growth, affiliation, community) that is linked to greater psychological well-being and better academic and non-academic outcomes (Ryan & Deci, 2009).

An educational setting can promote all three psychological needs. For instance Vallerand and colleagues (Vallerand, et al., 1997) introduced the model in which low levels of autonomy supportive behaviours from

critical social agents (teachers, parents, school administration) undermine students' perceptions of their own autonomy and competence which in turn decreases self-determined motivation. They (ibid.) studied lower educational achievement in the light of early school leaving. They revealed the contextual and motivational predictors of early school leaving by assessing students for their perception of their autonomy and the autonomy support and investigating which students would be more likely to still be in school a year after. They found that the students that felt more autonomous and had more autonomy support felt more competent and were more likely to stay in school a year after. In the classrooms where teachers are more autonomy supportive (e.g. letting students choose from various alternatives, listening to them and asking them for their point of view), students tend to become more intrinsically motivated, perceive themselves as more competent, and feel better about themselves, whereas in a classroom where teachers were more controlling (e.g. giving rigid directions or orders, supervising and monitoring too closely or not giving students the opportunity to propose choices and opinions that differ from those expressed by adults), students tended to lose intrinsic motivation, perceived competence and self-esteem (Ryan & Grolnick, 1986; Tsai et al., 2008), have lower educational achievement and are more prone to early school leaving (Vallerand, et al., 1997).

Intrinsic motivation is not only related to a higher quantity of knowledge but also to higher quality knowledge. In an experiment (Benware & Deci, 1984) students were given three hours to read a text. The first group was told they are going to be tested afterwards (low intrinsic motivation is expected) and the other that they will be given a chance to use their knowledge in practice by teaching others (higher intrinsic motivation is expected). The two groups did not differ significantly in the information memorized but did differ in conceptual knowledge. The findings were replicated in numerous studies around the world (Grolnick & Ryan, 1987; Kage & Namiki; 1990; Fortier, Vallerand & Guay, 1995).

Aim of the Study

Based on the rich empirical support and sound theoretical conception we aim at investigating the predictive power of intrinsic motivation for academic achievement in international comparative studies. In order to identify the level of intrinsic motivation of students we will focus on the indicators (items) measuring fulfilment of the three psychological needs that lead to intrinsic motivation: competence, autonomy and relatedness. International comparative studies together with reliable and valid measurement of achievement (in specific domains) measure also student's back-

ground information using background questionnaires. In order to analyse the predictive power of all three psychological needs for achievement, we firstly have to identify items (in the background questionnaires) indicating the fulfilment of all three psychological needs. In order to increase generalizability of the findings, we used four different international comparative studies: PIRLS (Progress in International Reading Literacy Study), ICCS (International Civic and Citizenship Survey), TIMSS (Trends in International Mathematics and Science Study), TIMSS Advanced (Trends in International Mathematics and Science Study Advanced). All studies measure achievement in a specific domain (PIRLS - reading comprehension; TIMSS and TIMSS Advanced - math and science achievement; ICCS - civic and citizenship literacy) and in a specific age group (PIRLS - 4th grade, TIMSS - 8th grade; TIMSS Advanced –13th grade); ICCS - 9th grade). The most recent data for Slovenia from the selected studies are used.

Specific objectives of this paper are:

– to identify indicators of competence, autonomy and relatedness in the pool of all items from background questionnaires of selected studies; these indicators have up to now not yet been identified and will be used in the present paper for the first time;
– to identify the predictive power (regression analyses) of perceived autonomy support for achievement in selected international comparative studies (controlling for SES);
– to identify the predictive power (regression analyses) of perceived competence for achievement in selected international comparative studies (controlling for SES);
– to identify the predictive power of perceived relatedness (regression analyses) for achievement in selected international comparative studies (controlling for SES).

Due to differences in the item pools of the studies used, the findings will be preliminary and used for further more in depth analyses of international comparative studies achievement predictors. The content of the items is nevertheless similar (also due to the studies being conducted by the same international organization: IEA International Evaluation Association).

Method

Participants

In order to increase the generalizability of our findings, the aim was to include the wider possible age and content range. Therefore four different international comparative studies (data bases) for Slovenia were used. Below each study with participating sample is presented in detail.

4th Grade - Reading.

Progress in International Reading Literacy Study 2011 (PIRLS 2011) is an international assessment of reading comprehension at the fourth grade which is conducted every five years (Martin & Mullis, 2013b). For our analysis data for Slovenia from 2011 study cycle were used. PIRLS uses a two-stage random sample design, with a sample of schools drawn as a first stage and one or more intact classes of students selected from each of the sampled schools as a second stage (Joncas & Foy, 2013). The target population of PIRLS are all students in their fourth year of formal schooling and therefore their mean age at the time of testing in each country is 9.5 years. Each sampled student answered a cognitive test and a background questionnaire.

8th Grade - Mathematics.

Trends in International Mathematics and Science Study 2011 (TIMSS 2011) is an international assessment of mathematics and science comprehension at the fourth and eighth grade of formal schooling, which is conducted every four years. As PIRLS, TIMSS also uses a stratified two-stage random sample design with firstly sampling schools and then sampling one or more whole classes at a sampled school (Joncas & Foy, 2013). The target population of TIMSS are students in their fourth and eighth year of formal schooling averagely aged at least 9.5 (fourth grade) or 13.5 (eighth grade) years at the time of testing. Since we used the PIRLS data for fourth grade and as already stated at the beginning, the aim of the article is to cover as wide an age range and knowledge range as possible, TIMSS 2011 Slovenian eighth grade sample for Mathematics was used for the purposes of this analysis. Since mathematics and science achievements in TIMSS 2011 are highly correlated ($r = 0.85$) we only used mathematics sample. Each sampled student answered a cognitive test and a background questionnaire.

9th Grade – Civics and Citizenship Knowledge.

International Civic and Citizenship Survey 2009 (ICCS 2009) focused on civics and citizenship content and knowledge. Again to cover the wid-

est age range possible ICCS Slovenian additional grade[1] database is used (students enrolled in Grade 9) in the analyses. The population of schools with Grade 9 students tested was identical to the population of schools with Grade 8 students tested (Schulz, Ainley & Fraillon, 2011) and the average age of students enrolled in Grade 9 should be 14.5 or higher. Slovenia used a two-stage cluster sampling, where schools were sampled within the country using probability proportional to size measured by the number of students enrolled in a school. Within each sampled school, an intact class from the target grade was sampled randomly and all students in that class were surveyed (Schulz et al., 2011). With these sampling procedures the representativeness of the selected test population was ensured. Each student answered a cognitive test and a background questionnaire.

13th Grade - Mathematics.
Trends in International Mathematics and Science Study Advanced 2008 (TIMSS Advanced 2008) is an international assessment of achievements in advanced Mathematics and Physics in the final year of upper secondary school (in Slovenia these are students in their 13th year of schooling). The survey measured achievement in two student populations, one in Mathematics and one in Physics. Again the Slovenian mathematics sample of students included in TIMSS Advanced 2008 was used for the purpose of this analysis. Mathematics sample was used since it was larger than the physics sample and therefore it is more representative for the age group. TIMSS Advanced uses the same two-stage sampling design as PIRLS 2011 and TIMSS 2011 (Arora, Foy, Martin & Mullis, 2009).

Instruments and Included Variables
For selected studies the data gathered with achievement test and background questionnaires were included. Included variables are listed below separately for all age groups.

All ages – All Surveys
Achievement Scores (Plausible Values).
To test achievement, all surveys use matrix-sampling approach where achievement items are divided into groups, blocks or sets and each achievement booklet is then made up of these sets of items according to a systematic arrangement (Mullis et al., 2009a; Mullis et al., 2009c; Schulz, Ainley, Fraillon, 2011; Arora, Foy, Martin & Mullis, 2009).

The PIRLS cognitive assessment is composed of 10 blocks of items. Each booklet consists of two blocks, with each block containing a reading passage and 12-17 associated items. One half of the blocks assess the

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[1]   The additional grade sample was used for estimating trends from CIVED 1999.

literary purpose and the other half assesses informational purpose. Eight blocks are then assigned to 12 booklets according to a specific plan that enables linking among booklets and balances position effects. The remaining two blocks (one literary and the other informational) are presented in a magazine format in the PIRLS reader[2] (Mullis et al., 2013).

TIMSS cognitive test is composed of packages of the entire pool of mathematics and science items. Each item appears in two booklets, providing a mechanism for linking together the student responses from various booklets. In TIMSS 2011 28 assessment blocks are distributed across 14 student achievement booklets. Each booklet consists of four blocks of items, two blocks of mathematics and two blocks of science items. (Mullis et al., 2009c).

ICCS cognitive test consisted of 80 items which were allocated to seven clusters that were assembled into a fully balanced rotated test design comprising of seven paper-based booklets (Schulz, Ainley, Fraillon, 2011). The ICCS assessment framework includes four content (civic society and systems; civic principles; civic participation; civic identities) and two cognitive (knowing; reasoning and analysing) domains.

The cognitive test or the assessment in TIMSS Advanced is composed of 14 item blocks – a total of 72 advanced mathematics items were included in the assessment. These items were distributed across 8 booklets. The design was chosen to ensure that each student responded to a sufficient number of items to provide a reliable measure (Arora, Foy, Martin & Mullis, 2009).

To derive student achievement scores for analysis and reporting Rasch one-parameter item response theory (IRT) model was used in all surveys. Since each student answers only some questions the surveys use multiple imputations (plausible values3) to obtain proficiency scores. In order to enhance the reliability student responses are combined with information about student's background using the "conditioning" scaling approach (Foy, Brossman & Galia, 2013; Schulz et al., 2011).

Socioeconomic Background (SES)
Variables or scales that each respective survey uses as a socioeconomic background indicator in their respective international reports were used in the present article as control variables of socioeconomic background in the regression analyses.

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2   PIRLS reader is a magazine-type format of reading booklet with the questions in a separate booklet.

3   There are five plausible values for each student in each of the databases and all five plausible values for each survey were included in the computing of the achievement score for a respective student.

PIRLS and TIMSS use scale for home resources for learning (AS-BGHRL in PIRLS and BSBGHRL in TIMSS). The scale combines answers to the questions on parents' education, parents' occupation, number of children's books and books at home and the availability of internet connection and their own room (Mullis et al., 2012b; Mullis et al., 2012a).

In ICCS three different measures for socioeconomic background of students were used (parental occupational status, parental educational attainment and home literacy resources). Since the parental occupational status (HISEI) explained the highest percentage of variance in civic knowledge we used this scale as a measure for socioeconomic background in our analyses (Schulz et al., 2010).

In TIMSS Advanced report number of books at home (MS2G-BOOK) was used as a measure of socioeconomic background (Mullis et al, 2009b).

4th Grade (PIRLS 2011).

Autonomy.

The autonomy of the student is measured with one set of questions ASBG07. In the set of questions ASBG07 students had to evaluate how often (*every day or almost every day, once or twice a week, once a month or twice a month or never or almost never*) the following things happen at home: *My parents ask me what I am learning in school; I talk about my schoolwork with my parents; My parents make sure that I set aside time for my homework; My parents check if I do my homework.* Cronbach alpha's for this set of questions is 0.61 which is relatively low due to small number of items included. This will be considered in further interpretation of results. In order to define the underlying structure of the question set measuring autonomy support the correlation matrix of the question set was subjected to factor analyses (method: principal axis factoring). The preliminary test showed the data are suitable for this kind of analyses (KMO = 0.661; Bartlett's Test of Sphericity ($\chi2$) = 1868.123; $p < .001$). The Kaiser-Guttman criteria (Eigenvalue over 1) revealed one factor explaining 28.75 % of the question set total variance. We named the factor *autonomy_PIRLS*. Factor loading ranged from 0.403 to 0.616 for selected sub questions. Higher values reflect higher degrees of autonomy. In the regression models *autonomy_PIRLS* was used.

Competence.

For competence Students Confident in Reading (ASBGSCR) scale was used. The scale or factor already existed in the PIRLS database and it was created based on students' degree of agreement (*agree a lot, agree a little,*

disagree a little, disagree a lot) with seven statements: *I usually do well in reading (+)[4]; Reading is easy for me (+); Reading is harder for me than for many of my classmates (-); If a book is interesting, I don't care how hard it is to read (+); I have trouble reading stories with difficult words (-); My teacher tells me I am a good reader (+); Reading is harder for me than any other subject (+).* Cronbach's alpha for these questions is 0.77. The higher values on this scale reflect perceptions of higher reading competence (Martin & Mullis, 2013a). In the regression model scale ASBGSCR (Student Confident in Reading) was used as measure for competence.

Relatedness.

We used a set of questions ASBG08 to measure relatedness. Students had to evaluate their agreement (*agree a lot, agree a little, disagree a little, disagree a lot*) on three statements: *I like being in school (+); I feel safe when I am at school (+); I feel like I belong at this school (+).* Cronbach alpha's for this set of questions is 0.66 which is relatively low due to small number of items included. This will be considered in further interpretation of results. In order to define the underlying structure of the question set measuring relatedness the correlation matrix of the question set was again subjected to factor analyses (method: principal axis factoring). The preliminary test showed the data are suitable for this kind of analyses (KMO = 0.655; Bartlett's Test of Sphericity $(\chi2)$ = 1917.110; $p < .001$). The Kaiser-Guttman criteria (Eigenvalue over 1) revealed one factor explaining 40.07 % of the question set total variance. We named the factor *relatedness_TIMSS*. Factor loading ranged from 0.564 to 0.690 for selected sub questions. The higher values on this factor represent higher students' perception of relatedness. Factor *relatedness_TIMSS* was used in the regression model as measure for relatedness.

8th grade (TIMSS 2011).
Autonomy.
As a measure of autonomy BSBG11 set of questions from the TIMSS background questionnaire was used. These questions were formulated in the same way as the question ASBG07 from PIRLS 2011, therefore see the previous section of the article (PIRLS 2011; *Autonomy*). Cronbach alpha's for this set of questions is 0.68 which is relatively low due to small number of items included. This will be considered in further interpretation of results. To define the underlying structure of the question set measuring autonomy the correlation matrix of the question set was subjected to factor

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4   In the bracket the method of item valuation is presented. The same approach of presenting the item valuations was used throughout the article.

analyses (method: principal axis factoring). The preliminary test showed the data are suitable for this kind of analyses (KMO = 0.715; Bartlett's Test of Sphericity (χ2) = 2683.139; p < .001). The Kaiser-Guttman criteria (Eigenvalue over 1) revealed one factor explaining 35.56 % of the question set total variance. Factor loading ranged from 0.515 to 0.667 for the selected set of questions. We named the factor *autonomy_TIMSS*. The higher values on this factor reflect higher students' perception of autonomy. In the regression model factor *autonomy_TIMSS* was used.

Competence.
The scale Student Confident in Mathematics (BSBGSCM) was used as a measure of competence. The scale is based on students' degree of agreement (*agree a lot, agree a little, disagree a little, disagree a lot*) to the nine following statements: *I usually do well in mathematics (+); Mathematics is more difficult for me than for many of my classmates (-); Mathematics is one of my strengths (+); I learn things quickly in mathematics (+); Mathematics makes me confused and nervous (-); I am good at working out difficult mathematics problems (+); My teacher thinks I can do well in mathematics lessons with difficult materials (+); My teacher tells me I am good at mathematics (+); Mathematics is harder for me than any other subject (-).* Cronbach's alpha for this set of questions is 0.89. The higher values on this scale reflect perceptions higher mathematics competence (Martin & Mullis, 2013a). In the regression model scale BSBGSCM (Student Confident in Mathematics) was used as competence predictor.

Relatedness.
For a measure of relatedness BSBG12 set of questions was used. Again the question was formulated the same as the question ASBG08 in PIRLS 2011 (see PIRLS 2011, *Relatedness*). Cronbach's alpha for this set of questions is 0.71. The correlation matrix of the question set was subjected to factor analyses (method: principal axis factoring) in order to define the underlying structure of the question set measuring autonomy. The preliminary test showed the data are suitable for this kind of analyses (KMO = 0.667; Bartlett's Test of Sphericity (χ2) = 2339.618; p < .001). The Kaiser-Guttman criteria (Eigenvalue over 1) revealed one factor explaining 44.40 % of the question set total variance. Factor loading ranged from 0.597 to 0.735 for the selected set of questions. We named the factor *relatedness_TIMSS*. The higher values on this factor reflect higher students' perception of relatedness. In the regression model factor *relatedness_TIMSS* was used.

9th Grade (ICCS 2009).

Autonomy.

To estimate autonomy scale Student's perception of openness in classroom discussion (OPDISC) was used. To derive this scale six statements to which students could answer with *never, rarely, sometimes* or *often* were used. These statements were: *teachers encourage students to make up their own minds (+); teachers encourage students to express their opinions (+); students bring up current political events for discussion in class (+); students express opinions in class even when their opinions are different from most of the other students (+); teachers encourage students to discuss the issues with people having different opinions (+); teachers present several sides of the issues when explaining them in class (+).* The scale's reliability (Cronbach's alpha) is 0.77. The higher values on the scale reflect perceptions of higher levels of classroom discussion and therefore a higher level of autonomy (Schulz, Ainley, & Fraillon, 2011). In the regression model scale *OPDISC* was used as a measure of autonomy.

Competence.

As a measure of competence we used Students' sense of internal political efficacy (INPOLEF). This scale is composed of six statements: *I know more about politics than most people my age (+); when political issues or problems are being discussed, I usually have something to say (+); I am able to understand most political issues easily (+); I have political opinions worth listening to (+); As an adult I will be able to take part in politics (+); I have a good understanding of the political issues facing this country (+).* Response options ranged from *strongly agree* to *strongly disagree*. The scale's reliability (Cronbach's alpha) is 0.86. The higher level on this scale reflects a higher sense of internal political efficacy and consequently competence (Schulz et al., 2011). As a measure of competence scale *INPOLEF* was used in the regression model.

Relatedness.

To measure relatedness scale Student's perception of student-teacher relation at school (STUTREL) was used. Scale is composed of five variables – students' answers to questions: *Most of my teachers treat me fairly, Students get along well with most of the teachers, Most teachers are interested in students' well-being, Most of my teachers really listen to what I have to say* and *If I need extra help, I will receive it from my teachers*. Response options ranged from *strongly agree* to *strongly disagree*. The scale's reliability (Cronbach's alpha) is 0.76. The higher values on this scale reflect perceptions of strong relations between students and teachers and therefore relatedness (Schulz,

et al., 2011). In the regression model scale *STUTREL* was used as a measure for relatedness.

13th Grade (TIMSS Advanced 2008).

Autonomy.

As a measure of autonomy three sub questions were used: MS2MACWP, MS2MDL05 and MS2MDL06. The students had to evaluate how often (*every or almost every lesson, about half the lessons, some lessons and never*) they do the following activities in their mathematic lessons: *We work problems on our own (+); We decide on our own procedures for solving complex problems (+); We communicate our arguments (+)*. Cronbach alpha's for this set of questions is 0.64 which is relatively low due to small number of items included. This will be considered in further interpretation of results. The correlation matrix of the question set was subjected to factor analyses (method: principal axis factoring) in order to define the underlying structure of the question set measuring autonomy. The preliminary test showed the data are suitable for this kind of analyses (KMO = 0.567; Bartlett's Test of Sphericity (χ2) = 1082.188; $p < .001$). The Kaiser-Guttman criteria (Eigenvalue over 1) revealed one factor explaining 48.82 % of the question set total variance. Factor loading ranged from 0.366 to 0.942 for the selected. We named the factor *autonomy_TIMSSAdv*. The higher values on this factor reflect higher students' perception of autonomy. In the regression model factor *autonomy_TIMSSAdv* was used.

Competence.

In the analyses three sub questions, namely MS2MWSWM, MS2MWSLT and MS2MWSEP, were used as a measure of competence. The students had to evaluate how important (*very important, important, unimportant or very unimportant*) were for them the following reasons for studying advanced mathematics: *I usually do well in mathematics (+); Studying or doing mathematics homework does not take me a lot of time (+); I expect that I will easily pass the tests (+)*. Cronbach alpha's for this set of questions is 0.6 which is relatively low due to small number of items included. This will be considered in further interpretation of results. In order to define the underlying structure of the question set measuring competence the correlation matrix of the question set was subjected to factor analyses (method: principal axis factoring). The preliminary test showed the data are suitable for this kind of analyses (KMO = 0.637; Bartlett's Test of Sphericity (χ2) = 619.652; $p < .001$). The Kaiser-Guttman criteria (Eigenvalue over 1) revealed one factor explaining 32.99 % of the question set total variance. Factor loading ranged from 0.549 to 0.604 for the se-

lected. We named the factor *competence_TIMSSAdv*. The higher values on this factor reflect higher students' perception of competence. In the regression model factor *competence_TIMSSAdv* was used as a measure for competence.

Relatedness.

Relatedness was measured with nationally added School climate scale (Kozina, Rožman, Vršnik Perše & Rutar Leban, 2012) that measure four dimensions of school climate: relations-school, relations-teacher and relations-students, organizational structure. We used first three dimensions in the analyses. The factors were composed of sub questions from Slovenian national question N5 (19 of 22 sub questions), which tried to evaluate the degree of agreement (*completely agree, agree, uncertain, disagree, completely disagree*) to statements on students' relations at school in general (e. g. *I like being at school; I am proud at my school*, etc.), student-teacher relations (e. g. *We get on well with our teachers; Inappropriate behaviour is always duly punished at our school*, etc.) and relations among students (e. g. *Students at our school have good relations* etc.). The scale is reliable (0.66 < α > 0.80). We used total scores on these three factors to create a new multidimensional relatedness scale. In order to define the underlying structure of the three factors measuring relatedness, the correlation matrix of the factors was subjected to factor analyses (method: principal axis factoring). The preliminary test showed the data are suitable for this kind of analyses (KMO = 0.609; Bartlett's Test of Sphericity (χ_2) = 1354.404; p < .001). The Kaiser-Guttman criteria (Eigenvalue over 1) revealed one factor explaining 50.46 % of the question set total variance. Factor loading ranged from 0.483 to 0.935 for the selected. We named the factor *relatedness_TIMSSAdv*. The higher values on this scale reflect higher students' perception of relatedness. In the regression model factor *relatedness_TIMSSAdv* was used as a measure for relatedness.

Procedure and Statistical Analyses.

For the analyses of the data we used two statistical programmes. First, we used IBM SPSS Statistics 23 for the calculation of internal reliability and for defining the underlying structure of the factors with the method Principal Axis Factoring, and secondly, we used IDB Analyser 3.2.19 for regression analyses, since this programme, unlike IBM SPSS Statistics, takes into account all five plausible values for student achievement in all mentioned surveys. Since the present analysis is a preliminary one, we used simple regression analyses instead of HLM. In the regression mod-

el achievement scores (all five plausible values) for each of the surveys are used as predicting variables.

Results

The results present the regression analyses where achievement score is predicted by competence, autonomy and relatedness. Moreover, we also included social and economic status in the regression models as a control variable.

Table 1. Descriptive statistics

	N	Age (s. e.)	Gender (%)		Average achievement score (s. e.)
			Female (s. e.)	Male (s. e.)	
PIRLS 2011	4466	9,9 (0,01)	48 (0,8)	52 (0,8)	530 (2,0)
TIMSS 2011	4415	13,9 (0,01)	49 (0,9)	51 (0,9)	505 (2,2)
ICCS 2009	3042	14,8 (0,01)	49 (0,8)	51 (0,8)	540 (2,6)
TIMSS Advanced 2008	2156	18,8 (0,01)	60 (1,8)	40 (1,8)	457 (4,4)

The average age of students included in PIRSL 2011 was almost 10 (9.9) and their average achievement score was 530 score points. Moreover, 4466 students participated in the PIRLS survey, among which 48% were girls and 49% were boys. In TIMSS 2011 4415 students were included in Slovenia, of which 49% were girls and 51% were boys. Their average achievement score on the cognitive test was 505 score points and their average age was 13.9 years. Likewise, in Slovenia 3042 students were included in ICCS (49% female and 51% male). Their average age was almost 15 (14.8) and their average score on ICCS cognitive test was 540 score points. In TIMSS Advanced 2156 students participated. There were 60% girls and 40% boys in the sample and their mean age was almost 19 years (18.8). Their average mathematics achievement was 457 score points.

The data shows competence, autonomy and socioeconomic background as significant predictors of achievement in PIRLS 2011, whereas relatedness is not a statistically significant predictor of achievement. If perceived reading competence increases by one unit (the average value), the students' reading achievement score increases by 12 score points (if autonomy, relatedness and SES are held constant). If autonomy raises by one unit while controlling for other predictors, then the students' reading achievement increases by almost 9 score points. However, if SES raises by one unit while controlling for other predictors, then the students' achievement increases by 17 score point. The regression model for PIRLS accounts for 31% of the variance of the students' reading achievement score.

Table 2. Predictive power of self-determination theory concepts for achievement.

	b (SE)	β (SE)	R²* (SE)
4th Grade - PIRLS 2011			
constant	235.00 (9.99)		
Competence (ASBGSCR)	11.52 (0.68)*	0.35 (0.02)*	
Autonomy (autonomy_PIRLS)	8.62 (1.61)*	0.10 (0.02)*	
Relatedness (relatedness_PIRLS)	-0.34 (1.64)	0.00 (0.02)	
SES (ASBGHRL)	17.08 (0.91)*	0.35 (0.02)*	0.31 (0.02)
8th Grade - TIMSS 2011			
Constant	167.03 (10.52)		
Competence (BSBGSCM)	19.78 (0.80)*	0.50 (0.02)*	
Autonomy (autonomy_TIMSS)	12.02 (1.32)*	0.14 (0.02)*	
Relatedness (relatedness_TIMSS)	2.70 (1.61)	0.03 (0.02)	
SES (BSBGHRL)	12.98 (0.83)*	0.25 (0.02)*	0.41 (0.01)
9th Grade - ICCS 2009			
constant	299.20 (14.46)		
Competence (INPOLEF)	1.92 (0.18)*	0.24 (0.02)*	
Autonomy (OPDISC)	1.43 (0.24)*	0.15 (0.02)*	
Relatedness (STUTREL)	0.38 (0.31)	0.04 (0.03)	
SES (HISEI)	1.27 (0.12)*	0.23 (0.02)*	0.16 (0.01)
13th Grade - TIMSS Advanced 2008			
constant	460.09 (3.81)		
Competence (competence_TIMSSAdv)	27.16 (2.84)*	0.24 (0.03)*	
Autonomy (autonomy_TIMSSAdv)	9.98 (3.02)*	0.11 (0.03)*	
Relatedness (relatedness_TIMSSAdv)	16.58 (3.17)*	0.18 (0.03)*	
SES (MS2GBOOK)	-5.86 (6.14)	-0.03 (0.03)	0.13 (0.02)

Notes. Owing to the nested sampling design, data were weighted with Total Student Weight (PIRLS, TIMSS, TIMSS Advanced) or Final Student Weight (ICCS). To increase the possibility of generalisation, we used adjusted R^2. Multiple regression was conducted (forced entry method) on IDB Analyzer (IEA DPC, v.3.2). The assumption of multicollinearity was tested on all data sets and was not violated (the VIFs were lower than 10 (Myers, 1990) and varied between 1.12 and 1.25). Statistically significant (p > 0,05) coefficients are marked with *.

The regression analysis for TIMSS 2011 also shows that relatedness is not a statistically significant predictor of achievement. Howev-

er, SES, competence and autonomy are statistically significant predictors of achievement. Every unit increase in perceived competence is associated with a 20 score point increase in the students' mathematics achievement (if other predictors are held constant) and every unit increase in perceived autonomy is associated with a 12 score point increase in students' mathematics achievement (if other predictors are held constant). Moreover, every unit increase in SES is associated with a 13 score point increase in students' mathematics achievement (if other predictors are held constant). The regression model for TIMSS achievement accounts for 41% of the variance of the students' mathematics achievement.

The data again shows SES, competence and autonomy as significant predictors of achievement in ICCS 2009 survey as well, whereas relatedness again is not a statistically significant predictor of achievement. The results show that if competence increases by one unit, the students' civic and citizenship achievement score increases by 2 score points (if all other predictors are constant). If autonomy increases by one unit, then the students' civic and citizenship score increases by a little bit more than 1 score point while controlling for other predictors. Moreover, if SES increases by one unit, then the students' civic and citizenship knowledge increases by 1 score point too (if other predictors are held constant). The model accounts for 16% of the variance of the students' civic and citizenship achievement.

The regression analysis for TIMSS Advanced however shows that all three SDT predictors (competence, autonomy and relatedness) of mathematics achievement are statistically significant, whereas SES is not a statistically significant predictor. The results show that if competence increases by one unit, the students' advanced mathematics score increases by 27 score points (if all other predictors are held constants). If autonomy increases by one unit, then the students' advanced mathematics score increases by almost 10 score points (again if all other predictors are constant). Moreover, if autonomy and competence are held constant and relatedness increases by one unit, then students' advanced mathematics score increases by almost 17 score points. The model accounts for 13% of the variance in the students' advanced mathematics achievement.

Except for TIMSS Advanced, where the strongest predictor for advanced mathematics score is autonomy, and PIRLS, where the strongest predictor for reading score is SES, competence is the strongest predictor among all other predictors for other surveys (TIMSS and ICCS). Moreover, relatedness is a statistically significant predictor only in TIMSS Advanced regression model. In all other models relatedness is not a statistically significant predictor of achievement.

Discussion

The study aimed at identifying the possible indicators of psychological needs fulfilment in the background questionnaires of selected international comparative studies in order to analyse the predictive power of these indicators for educational achievement across content domains. Rough comparisons were made across different studies, different age groups and content domains. The study is the first of this type (to use the international comparative studies in order to find possible indicators of psychological needs fulfilment among students and their relationship with academic achievement) in Slovenia. Even though the data available and analyses conducted are rough and preliminary, the findings show consistency across studies and across age groups. In all samples included, self-perceived confidence and self-perceived autonomy are significant predictors of students' academic achievement. The more competent and the more autonomy supported students feel, the higher on average is their achievement (when controlling for SES). The percentages of explained achievement variances with the included indicators of psychological needs (SES included) are largest in 4th and 8th grade students, followed by 13 and 9th grade students.

Self-perceived competence is a significant predictor of student's achievement in various content domains: reading, maths and civic education and across age groups from 4th to 13th grade. The competence is the strongest predictor out of the ones included (compared to autonomy, relatedness and SES) in 8th, 9th and 13th grade indicating that an increase in perceived competence would result in significant increase in achievement. In 4th grade, SES is the strongest predictor and is followed by perceived self- competence. When students feel their efforts and abilities are being recognized, they use the learning situation for building their academic success. We see consistency across samples even though the achievement domain varies and competence measures vary. The items measuring self-perceived competence varied across studies and focused on specific domains of the study (e.g. self-perceived reading competence in PIRLS) and varied in the number of items measuring competence (from 4 in TIMSS Advanced to 9 in TIMSS). The content of the items is nevertheless similar (also as already mentioned due to the studies being conducted by the same international organization).

The results are in line with research literature indicating self-perceived competence (self-efficacy) as one of the most prominent predictors of academic success. Self-efficacy is directly related to behaviour in academic tasks (e.g. the effort, persistence in the tasks despite obstacles

and challenges) (Maddux, 2009; Ragozzino et al., 2003, Motti-Stefanidi & Masten, 2013). High perceived self-efficacy for self-regulated learning contributes to better learning outcomes and also increases the likelihood of remaining in school (Caprara, Fida, Vecchione, Del Bove, Veccio, & Barbaranelli, 2008). Competence being the strongest predictor is in line also with initial research findings of Ryan and Deci (2002) that autonomy itself is not enough for gains in academic achievement - the competence takes (according to the authors of the framework) the leading role. Optimal functioning and high engagement (with active participation in learning) in school setting is both a result of high autonomy support and self-perceived competence.

Practical implications when promoting competence at the school and classroom level involve mastery goal structure (Wang & Holcombre, 2010). Mastery goal structure promotes positive and effort based praise while avoiding pressuring students for correct answers or high grades (Wang & Holcombe, 2010) as opposed to performance goal structure. Mastery type school climate provides students with more opportunities to feel successful. Mastery goal structure also provides more opportunities for students to work together (support for relatedness) and not compete against each other. In order to foster student's sense of competence, school community collaboration can be of use as well. For instance different forms of project community based work can provide an example of students' knowledge being directly used and reinforce their perception of self-efficacy. These types of activities (mentoring and tutoring programs, contextual learning and job shadowing) have research support as well (Epstein et al., 2009). And also as shown in the experiment by Benware and Deci (1984) when students learn in order to use their knowledge, their knowledge is more conceptual. One example of this type of collaboration would be for instance project work on the agricultural planning of planting local green areas in which representatives of a local community would cooperate with biology teachers and students of a local school.

The second most important predictor of academic achievement, out of included indicators of psychological needs fulfilment, is self-perceived autonomy. In 8th, 9th and 13 grade the predictive power of self-perceived autonomy is similar (8th grade) or even higher (9th and 13 grade) when compared to SES as a predictor of academic achievement. Autonomy is a building stone of intrinsic motivation. Students with a greater sense of autonomy in school have better school outcomes such as classroom engagement, persistence, enjoyment and achievement (Wang & Holcombe, 2010).

Autonomy was measured differently in selected studies: in PIRLS and TIMSS the only items related to autonomy were indicated to perceived autonomy support at home (a lack of control over school work). In ICCS and in TIMSS Advanced studies the autonomy measure represented the perceived autonomy in classroom (autonomy support from teachers). The autonomy support is a significant predictor of student's achievement when the autonomy is supported at home or in the classroom. The perceived parental autonomy support was significantly related also to achievement in PISA study (math, science and reading literacy) (Rutar Leban, Vršnik Perše, Kozina, Pavlović, 2009). Practical implications suggest various activities inside the classroom as well as in the form of school-community collaboration. For instance, given the choice and supporting autonomy in organizing and conducting project work fosters their sense of autonomy. As already mentioned in the introduction autonomy support from teachers (e.g. letting students choose from various alternatives, listening to them and asking them for their point of view) increases students intrinsic motivation (Ryan & Grolnick, 1986; Tsai et al., 2008) and have higher educational achievement (Vallerand, et al., 1997). Previously mentioned school community collaboration fosters autonomy as well. With students planning the whole project their autonomy would be supported.

Relatedness was a significant predictor in TIMSS Advanced study (13th grade students) but not in other age groups. This could be due to developmental characteristics of the sample. Although the need to connect and belong is likely to be pervasive throughout one's life, research has suggested that during the period of adolescence the need to connect with others through mutually supportive relationships is at its peak (Wang & Holcombe, 2010). Nevertheless since the 8th and 9th grade students are in the period of adolescence as well the results would need some extra elaboration in future research. Relatedness refers in its core to the strengths of ones connections to others. And a sense of connectedness to teachers and peers in school is associated with multiple indicators of academic motivation and engagement (Wang & Holcombe, 2010) indicating that the association between relatedness and achievement is indirect (through engagement) which results in nonsignificant prediction in most of the samples included in the analyses. Engagement is according to Wang and Holcombe (2010) composed of three interrelated dimensions: behavioural, emotional and cognitive engagement. When all three are addressed and supported, academic outcomes are increased. Relatedness supports emotional engagement. And emotional engagement is, according to re-

search review (Wang & Holcombe, 2010), not directly related to academic achievement.

Even though our results have not wholly supported the importance of the relatedness in academic achievement we believe that it has to be addressed also as a support for autonomy and competence. In future research one focus could be in the elaboration in more detail of the relationship between all three predictors. Social support fosters feeling of social connectedness, which is required in order for children to internalize social standards (for instance value of education) and to develop respect for social institutions (also school) (Ellias & Hayes, 2008). With collaboration in and outside of school students build their own social network, social capital that is as an important well-being indicator as is material capital (Morenoff & Sampson, 2008). Even if a child or adolescent possesses the required skill for school success, motivation to use them is related to perception of social support for school related activities (from parents and community).

Together with the research relevance of the findings (congruency with the SDT theoretical assumptions), the findings have high practical value as well. Individuals seek experiences that fulfil their need for competence, autonomy and relatedness through interaction with the environment (Deci & Ryan, 2002). As said the theory proposes that the degree to which students perceive that the school context meets these psychological needs determines the level of student's engagement in school. We can use school related activities as a source of activities that can foster student's self-perceived autonomy, competence and relatedness. Intrinsically motivated learning can be greatly influenced by social environments (Ryan & Deci, 2009). For instance, the key feature is autonomy supporting teacher's behaviour. When teachers support students' autonomy they achieve more, learn conceptually and stay in school longer (Reeve, 2002). An important emphasis has to be put also on teachers' motivation and the quality of their teaching. Various studies of elementary and high school students (e.g. Hardre & Reeve, 2003; Jang, Reeve and Deci, 2010) show that teachers' autonomy support is related to teachers' own autonomous motivation and later work engagement.

As pointed out by Ryan and La Guardia (1999, in: Ryan & Deci, 2009) the importance of autonomy and competence support needs to be recognized in the school setting also in the light of addressing students at risk (e.g. low achieving students, students prone to early school leaving) even more since the first response of teachers and parents in situations of low achievement and anticipated early school leaving is adding more controls (e.g. scheduled time for studying, constant control over school

work...) and additional pressures to the students, which in a way closes the door for intervention and even lowers their motivation for learning and staying in school. Support for autonomy inside the classroom, inside school and also using community relevant activities, which would affect the relatedness, autonomy and competence as well - increase students' motivation for learning and continuing their education. As seen in our data the parental support (lack of controlling behaviour) for autonomy plays a vital part as well indicating our role in educating parents as parents meaning their role of autonomy support and of the developmental characteristics of their adolescents.

Conclusion

The findings support the importance of intrinsic motivation for academic achievement in various content domains as well as in various age groups. Even though the measures are rough and not directly comparable the findings show consistency. Since the results show somehow a different pattern in 13th grade, these results would benefit from further investigation of the role that all three psychological needs play in academic achievement in different developmental periods (with the same and comparable measure). The measures used are at this point rough – the international comparative studies are not designed to specifically measure perceived competence, autonomy and relatedness, therefore the findings should be understood as preliminary and as a starting point for future more in depth analyses with more consistent measures of all predictors as well as the use of more advanced statistical techniques (e.g. hierarchical regression models).

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