Competence, autonomy, and relatedness in the classroom: understanding students' motivational processes using the self-determination theory

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A B S T R A C T

The purpose of the current study is to examine the relationships between need satisfaction, motivation, and outcomes as well as the differential effects of the three psychological needs. The sample consisted of 1549 students from 10 secondary schools in Singapore. Structural equation modelling (SEM) analysis showed that students' psychological needs are positively related to autonomous motivation, and this in turn, lead to higher enjoyment, value and lower pressure. On the other hand, the three psychological needs were negatively related to controlled motivation. Controlled motivation was positively related to pressure but negatively related to enjoyment and value. In terms of the differential effects of the three psychological needs, relatedness contributed strongly to autonomous motivation, compared to autonomy and competence. In contrast, while autonomy and relatedness contributed to controlled motivation negatively, competence positively predicted controlled motivation. Finally, competence was found to link to pressure in a negative way. In summary, the findings of the current study provide support to the propositions of SDT and add some insight to the differential effects of the three psychological needs.

1. Introduction

For decades, researchers have established the connection between students' motivation and many positive learning effects (e.g., Ryan and Deci, 2000). When students are highly motivated, they tends to stay engaged and persist longer, and acquire knowledge in a more coherent form, apply their knowledge more often, and achieve higher academic performance over the long term (e.g., Deci and Ryan, 1994; Reeve, 2009). Focusing on nurturing students' "joy of learning" or intrinsic interest is recognized by key educational policy makers as a key factor in enhancing lifelong learning in Singapore schools in recent years (Wang, 2017). Therefore, the motivational processes involving intrinsic interest need further investigation. The purpose of this study was to examine the motivational processes in the classroom using self-determination theory (SDT, Ryan and Deci, 2017) and to examine the differential effects of the three psychological needs within SDT.

The former Minister of Education (Schools), Singapore, Mr. Ng Chee Meng, coined the term "joy of learning" and equates it to when students are intrinsically motivated, love what they are doing in class, and enjoy attending school (Ng, 2017). To illustrating the concept further, Wang and other researchers (e.g., Reeve, 2009; Wang, 2017) illustrates what a classroom could look and feel like when the these principles are in place: Teachers are able to meet their students' core psychological needs of competence, autonomy, and relatedness and create interesting and challenging lessons that are relevant to their lives. Students are given appropriate levels of challenges and they are able to make decisions about their learning. When they are faced with difficulties, the support system is in place to help them. Through this process, students become more interested in learning. When teachers see motivated students, they too, become more interested to teach.

The above mentioned constructs are the core constructs of SDT. This approach is beginning to be widely adopted in Singapore schools within the Singapore Teaching Practice framework (Ministry of Education, 2017). SDT conceptualizes psychological needs as essential nutrients that are required for optimal functioning, growth and well-being (Deci and Ryan, 2000). The theory posits that goal directed behaviours are driven by three innate psychological needs: autonomy (the need to feel ownership of one's behavior), competence (the need to produce desired outcomes and to experience mastery), and relatedness (the need to feel connected to others) in every human being. When the three psychological needs are satisfied in a particular context, intrinsic motivation will increase. People engage in activities that interest them with a full sense of

volition, and without the presence of external rewards or constraints. On the other hand, if the three psychological needs are thwarted, intrinsic motivation will be undermined. Social contexts that support students' autonomy, competence and relatedness promote intrinsic motivation (Liu et al., 2014; Wang et al., 2017).

Vallerand and Losier (1999) suggest that the relationships between need satisfaction and outcomes are mediated by different types of motivation. There are four main types of motivation or behavioural regulations with different degrees of self-determined motivation. They are intrinsic, identified, introjected, and external motivation. Intrinsic motivation is when an individual chooses to engage in an activity for its own sake, whether for interest, pleasure or satisfaction (Ryan and Deci, 2017). Identified regulation is when where behaviours are freely chosen by individuals because they are personally important to them. The behaviour represents the individual's own goal, and the source of motivation is feelings of 'want' rather than 'ought'. Intrinsic and identified regulations can be combined to form an autonomous motivation composite (Sheldon et al., 2004). Introjected regulation is when behaviours that are only partially internalized and which are performed out of guilt avoidance or ego enhancement. External regulation represents behaviours that are controlled by external means, such as rewards or external authority. Introjected and external regulation can be combined to form a controlled motivation composite (Sheldon et al., 2004; Vansteenkiste et al., 2004).

Autonomous motivation was found to be associated with numerous positive outcomes, including engagement, creativity (e.g., Connell and Wellborn, 1991; Koestner et al., 1984), better performance (e.g., Grolnick et al., 1991), persistence at school, (e.g., Vallerand et al., 1997), as well as more positive psychotherapy outcomes (https://www.sciencedirect.com/science/article/pii/S0191886910005258, Zuroff et al., 2007). On the other hand, controlled motivation negatively correlated with them (Milyavskaya and Koestner, 2011; Vallerand et al., 1993).

Coming back to the three psychological needs, are the three psychological needs equally important in a particular domain, or in a particular subject? Research into the need satisfaction in SDT has highlighted that autonomy and competence needs are essentials for the maintenance of intrinsic motivation (Deci et al., 1994). The need for relatedness is less clear, particularly in the classroom, but is beginning to be one of the focus in SDT research (Ryan and Deci, 2017).

The purpose of the current study were to examine the motivational processes of need satisfaction, motivation, and outcomes and the multivariate relationships of needs and associated outcomes. According to SDT literature and the motivational sequence proposed by Vallerand and Losier (1999), it is hypothesized when the students' psychological needs

are satisfied, they would be positively related to autonomous motivation, and this in turn, would lead to higher enjoyment and value and lower pressure. On the other hand, the three psychological needs would be negatively related to controlled motivation. Controlled motivation would be positively related to pressure but negatively related to enjoyment and value (see Fig. 1).

2. Methods

2.1. Participants

The sample consisted of 1549 students from 10 secondary schools in Singapore. There were 757 boys and 775 girls (17 missing) in the study with mean age of 14.16 years old ($SD = 1.08$). These schools were coeducational and considered as main-stream government schools in Singapore.

2.2. Procedure

Following ethical approval from the university Ethical Review Board, the Ministry of Education was then contacted for permission to collect data from schools. After which, emails were sent to school principals for their voluntary participation in the study. The researcher then followed up with schools that agreed to participate to arrange for the administration of the questionnaire. The participants took about 30 minutes to complete the questionnaire. Participants were informed about the nature of the research project before administration of the questionnaires. Informed consent of the participants was then obtained. They were told that their participation in the study was voluntary and they could withdraw at any time and confidentiality would be assured.

2.3. Measures

2.3.1. Students' need satisfaction

Students were asked to report the degree of satisfaction of their three psychological needs by responding to 16 items from the stem 'How do you feel when you are in this class?' (Taylor and Ntoumanis, 2007). There were six items referring to Student Need for *Autonomy* (e.g. 'I can decide which activities I want to practice in this class'), five items referring to Student Need for *Competence* (e.g. 'I think I am pretty good in this class'), and five items referring to Student Need for *Relatedness* (e.g. 'In this class I feel supported'). Responses were reported on a 7-point scale ranging from 1 (*not at all true*) to 7 (*very true*).
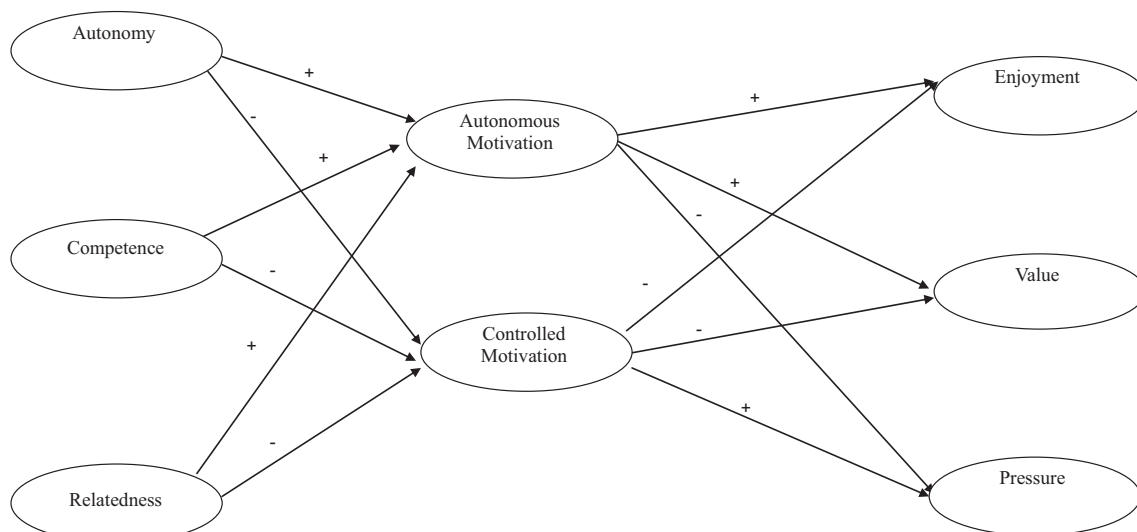

Fig. 1. Hypothesised model of students' motivational processes.

2.3.2. Students' motivational regulation

Students reported their motivational regulations using scale adapted from Perceived Locus of Causality questionnaire (PLOC) (Goudas et al., 1994). Subscales in the questionnaire were Intrinsic Motivation, Identified Regulation, Introjected Regulation, and External Regulation. Amotivation was not used in this study. The questionnaire contained 14 questions from the stem 'I participate in this class. . . '. Three items for each subscale were used to assess *Intrinsic Motivation* (e.g. 'because learning things in this class is fun'), and *Identified Regulation* (e.g. 'because I want to improve academically'). Four items for each subscale were used to assess *Introjected Regulation* (e.g. 'because I want the teacher to think I'm a good student'), and *External Regulation* (e.g. 'because I will get into trouble if I don't'). Responses will be reported on a 7-point scale ranging from 1 (*not at all true*) to 7 (*very true*). *Intrinsic Motivation* and *Identified Regulation* were then combined into *Autonomous* Motivation, whereas *Introjected Regulation* and *External Regulation* were combined into *Controlled* Motivation.

2.3.3. Intrinsic motivation inventory

The students' levels of intrinsic interest outcomes such as perceptions on enjoyment, value, and pressure during learning were assessed using the Intrinsic Motivation Inventory (IMI) (McAuley et al., 1989)

Students responded to 12 questions from the stem 'How do you feel when you are in this class?'. Four items for each subscale were used to measure the *Enjoyment* (e.g. 'I enjoy learning in this class very much'), *Value* (e.g. 'I believe learning in this class can be of some value to me'), and *Pressure* (e.g. 'I feel very tense when leaning in this class'). Responses were made on a 7-point Likert scale ranging from 1 (*Not at all true*) to 7 (*Completely true*).

2.4. Data analysis

Confirmatory factor analysis (CFA) was conducted to examine the factorial validity of all the measures using Mplus software (Muthén and Muthén, 2014). The internal consistency coefficients (alphas) of the scales were also computed. Descriptive statistics and the Pearson product-moment correlations of the main variables were tabulated. After which, Structural Equation Modelling (SEM) was used for the main analysis. Relationships among latent variables which are components of students' need satisfaction, motivation regulations, and intrinsic interest were analysed. SEM was used in exploring the predictive pathways from student need variables (*Competence, Autonomy*, and *Relatedness*) to individual student intrinsic interest outcome variables (*Enjoyment, Value*, and *Pressure*) through student motivational regulations (*Autonomous* and *Controlled*) as mediators.

All the models built were evaluated for goodness of fit using various fit indices. In the initial analyses, there was evidence of multivariate nonnormality in the distribution. Therefore, Robust Maximum Likelihood method was used as the estimation method. The Chi-Square statistic tests whether the model-implied variance-covariance matrix is significantly different from the variance-covariance matrix observed in the sample data. It is a measure of exact fit and a strict test of model fit. But it is known Chi-Square is affected by the sample size. For models with large number of cases (400 or more), the Chi-Square is almost always significant. So, models representing close fit should also be considered acceptable, and multiple criteria should be used to assess goodness-of-fit. Chi-Square, degree of freedom and *p*-value are always reported as a longstanding practice. A value of $\chi2/df$ smaller than 3.0 indicates good model fit to the data (Kline, 2005).

The Comparative Fit Index (CFI) is an incremental fit index and it compares the hypothesized model against a null model. CFI has a range of 0–1 and values greater than 0.95 are considered to indicate a satisfactory fit of the model to the data (Hu and Bentler, 1999). The NFI is computed using the difference between the chi-square value for the proposed model and the null model. In the null model, the covariances in the covariance matrix for the latent variables are all assumed to be zero. Tucker Lewis

Index (TLI) or Non-Normed Fit Index (NNFI) estimates the relative improvement per degree of freedom of the target model over an independence model and ranges from 0 to 1. Hu and Bentler (1999) recommend above values higher than .90 as indication of good fit to the data.

Root-Mean-Square Error of Approximation (RMSEA) assesses how poorly the model fits the data and measures the discrepancy per degree of freedom. The RMSEA is a fit index adjusted for parsimony. When two models have a similar model fit, a more parsimonious model is preferred. This fit index is very sensitive to model misspecification and it is widely used. A RMSEA value of about .05 or less reflects a model of close fit, whereas values between .05 and .08 indicate reasonable fit (Browne and Cudeck, 1992).

Wald and Lagrange Multiplier (LM) tests were used for model modification after testing the hypothesized model. The Wald test assesses whether any free parameters of a model can be restricted without substantial loss of information (Bentler, 1995). The LM tests whether any parameters that were set to zero in the model are, in fact, not zero. It tests the effect of adding free parameters to a model (Bentler, 1995; Byrne, 2006). These tests were conducted to examine any potential variations to the hypothesized model which make theoretically sense.

3. Results

3.1. Descriptive statistics

The results of the Confirmatory Factor Analysis (CFA) of all the measures are shown in Table 1. All the measurement models showed acceptable fit with PLOC showing a typical slightly lower fit, compared to the other two measurement tools. Table 2 shows the descriptive statistics including internal reliabilities, range, means, standard deviations, skewness and kurtosis of all the variables. The internal consistency of all subscales demonstrated acceptable internal reliability ranging from .69 to .90.

The students reported moderately high in relatedness, autonomous motivation, enjoyment and value, and low in pressure. The zero-order correlations among the key variables are shown in Table 3. In general, the three psychological needs were positively correlated with one another. All three psychological needs were positively associated with autonomous motivation, enjoyment and value, and negatively related to pressure. Autonomous motivation was positively related to enjoyment and value and negative associated with pressure. Controlled motivation was positively associated with pressure.

The results of the hypothesised structural equation modelling produced the following indices: $\chi^2_{SB} = 1360.64$, $df = 238$, $\chi^2_{SB}/df = 5.71$, $p < .001$, NFI = .907, CFI = .922, TFI = .909, and RMSEA = .060, 90% CI of RMSEA = .057 to .063. The standardised solutions and error variances of the hypothesised model are shown in Fig. 2. Based on the adequacy of most of the fit indices, the proposed model was supported. The model accounted for 93.5% variance in enjoyment, 80.6% in value, and 58.2% variance in pressure.

The Wald Test did not suggest any parameters be dropped for the model but the LM Test revealed a one path to be added from competence

Table 1
Fit indices for the CFA models.

Model	SBχ^2	df	SBχ^2/df	NFI	CFI	TFI	RMSEA (90% CI)
Need Satisfaction	525.05	84	6.25	.946	.954	.942	.063 (.058, .068)
PLOC	582.86	65	8.96	.914	.922	.891	.077 (.072, .083)
Intrinsic Motivation	235.91	50	4.72	.961	.969	.959	.053 (.046, .060)

NFI = Robust Normed Fit Index; CFI = robust Comparative Fit Index; TFI = Tucker Lewis Index; RMSEA (90% CI) = robust Root Mean Square Error of Approximation (90% confidence interval).

Table 2
Cronbach's alphas, range, means and standard deviations for all variables.

Variable	α	Range	Mean	SD	Skewness	Kurtosis
1. Competence	.84	1 to 7	4.43	1.21	-.27	-.06
2. Autonomy	.84	1 to 7	4.33	1.16	-.26	-.04
3. Relatedness	.90	1 to 7	4.62	1.31	-.31	-.25
4. Autonomous Motivation	.88	1 to 7	5.16	1.17	-.52	.21
5. Controlled Motivation	.81	1 to 7	3.80	1.19	-.01	-.17
6. Enjoyment	.90	1 to 7	4.52	1.41	-.24	.25
7. Value	.87	1 to 7	5.15	1.25	-.50	.12
8. Pressure	.69	1 to 7	3.32	1.15	-.06	.16

to pressure, this resulted in a slightly improved model [χ^2_{SB} = 1219.48, df = 237, χ^2_{SB}/df = 5.14, NFI = .917, CFI = .932, TFI = .920, and RMSEA = .056 (.053, .059)]. The standardised solutions and error variances of the hypothesised model are shown in Fig. 3.

There were differential effects of the three psychological needs on motivation. Specifically, relatedness contributed strongly to autonomous motivation, compared to autonomy and competence. On the other hand, while autonomy and relatedness contributed to controlled motivation negatively, competence positively predicted controlled motivation. Finally, competence was found to link to pressure in a negative way.

4. Discussion

SDT has been widely adopted in understanding and predicting motivation in the classroom. The theory posits that intrinsic motivation is

enhanced when satisfaction of three psychological needs of autonomy, competence, and relatedness is achieved. This forms the core of five mini-theories in SDT, termed as the Basic Psychological Need Theory (BPNT). People are motivated to satisfy these needs because they are considered essential for self-growth, social development and personal well-being (Deci and Ryan, 1985, 1991; Ryan and Deci, 2000). The purpose of the current study were to examine the relationships between need satisfaction, motivation, and outcomes as well as the differential effects of the three psychological needs.

In this study, the descriptive statistics presented a positive motivation profile of Singapore students. It was found that students reported high autonomous motivation, competence, relatedness, enjoyment and value. In addition, they scored low in pressure in the classroom. The fact that Singapore students are highly motivated could be the reason for Singapore to emerge as one of the top performers in international assessments such as Programme for International Student Assessments (PISA; OECD, 2015) and The Trends in International Mathematics and Science Study (TIMSS; National Centre for Education Statistics, 2016).

The results of the SEM supported the hypothesised model in that the three psychological needs positively predicted autonomous motivation, and in turns, positively predicted enjoyment and value and negatively predicted pressure. On the other hand, psychological need satisfaction was found negatively associated with controlled motivation. Controlled motivation positively predicted pressure but was negatively associated with enjoyment and value. It is noteworthy that the model accounted for a large proportion of variance in enjoyment, value and pressure. The findings confirm the propositions of SDT (Ryan and Deci, 2017). In addition, the mediating roles of motivation between need satisfaction

Table 3
Zero-order correlations between all variables of the overall sample.

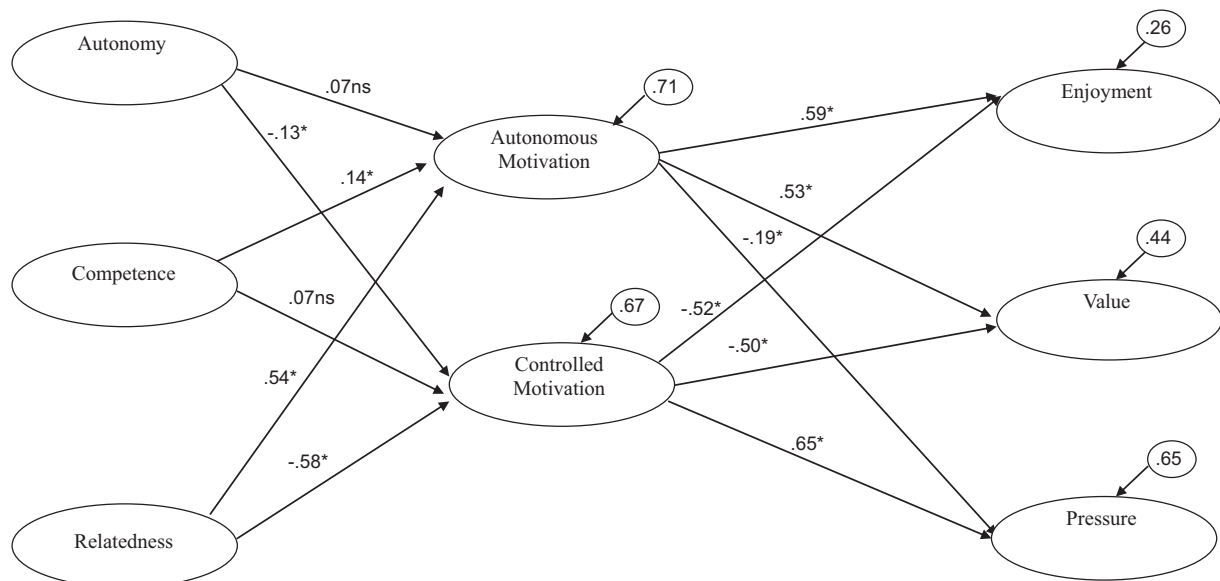|	1	2	3	4	5	6	7	8	9	10	11
1. Competence	1.00										
2. Autonomy	.63**	1.00									
3. Relatedness	.68**	.78**	1.00								
4. Autonomous Motivation	.49**	.52**	.57**	1.00							
5. Controlled Motivation	- .05	- .14**	- .08	.06*	1.00						
6. Enjoyment	.58**	.68**	.71**	.67**	- .13**	1.00					
7. Value	.50**	.58**	.63**	.72**	- .04	.77**	1.00				
8. Pressure	- .50**	- .43**	- .48**	- .30**	.20**	- .47**	- .41**	1.00			

*$p < 0.05$, **$p < 0.01$.

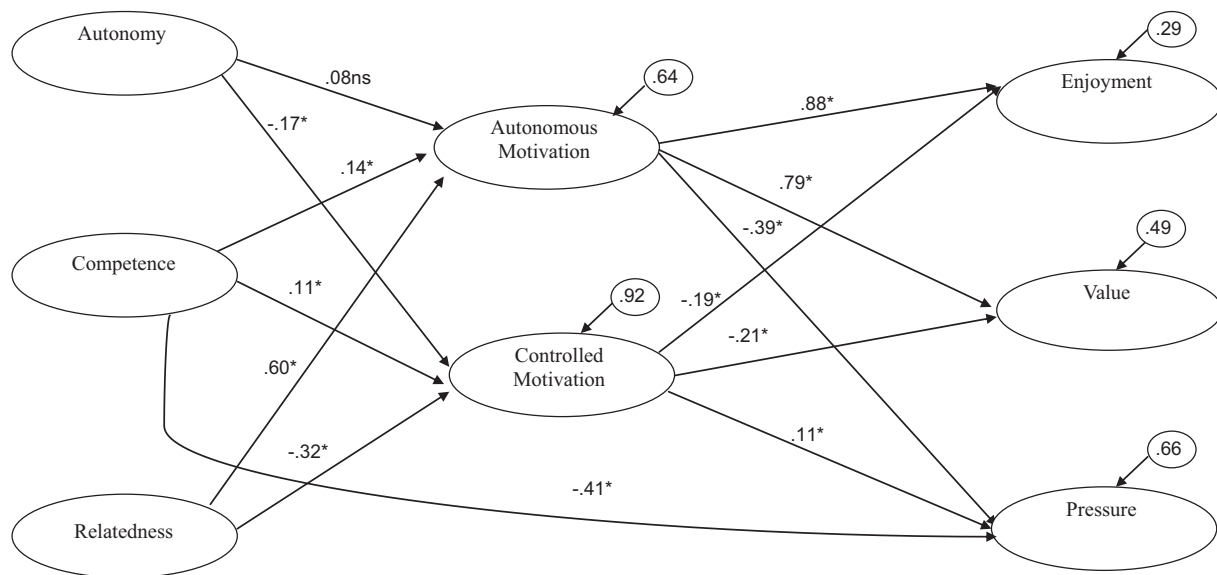**Fig. 2.** Standardised Solutions of the SEM model of students' motivational processes.

Fig. 3. Standardised Solutions of the revised SEM model of students' motivational processes.

and outcomes are also supported (Vallerand and Losier, 1999).

This study contributes to the literature in providing insights into the differential effects of the three psychological needs. Most of the previous studies load the three psychological needs to one latent factor overall need satisfaction (e.g., Standage et al., 2005), in doing so, the effects of each need on motivation and outcomes will be masked. As such the relative impact of each need is not known. The results of the current study supports SDT in that need satisfaction leads to autonomous motivation. Specifically, relatedness is the strongest contributor to autonomous motivation, compared to autonomy and competence. In addition, autonomy and relatedness negatively predicted controlled motivation. The only exception is need for competence.

Most of the studies in the SDT literature suggest all the three psychological needs to be satisfied for intrinsic motivation to be enhanced (Niemiec and Ryan, 2009). Not many studies examine the relative effects of each psychological need. Sheldon and Filak (2008) experimentally manipulate the three psychological needs within the social context in a boggle game by creating a 2 (autonomy support: yes or no) x 2 (competence support: yes or no) x 2 (relatedness support: yes or no). They found that competence support and relatedness support each had unique main effects upon most of the outcomes. The results of this study support previous studies in that the three psychological needs are distinct and unique.

Relatedness is one of the most ignored psychological needs in the SDT literature until recently. It is only recently that Ryan and Deci (2017) have included the relationship motivation theory (RMT) as the latest mini-theories of SDT. RMT recognizes relatedness as a core psychological need in its own right. This study found that relatedness was among the strongest predictors of autonomous motivation in the classroom.

Competence was found to negatively related to pressure. This is consistent with SDT. As competence is a reflection of one's belief about ability to produce desired outcomes, it is not surprising that this need could be negatively related to perceived tension or pressure.

There are a few limitations of the current study that need to be addressed in future studies. Firstly, the study is cross-sectional and self-reported. While the work does offer some confirmatory evidence for substantive aspects of SDT, the results of this study present correlations rather than predictive relationships. It is difficult to conclude the causal effects of the relationships. Future field experiments or intervention studies need to be conducted to tease out the causal relationships of the variables. Second, the data could be nested by class or by school at a

higher level, future studies need to examine the multilevel effects of the data. Finally, the current study did not look at need frustration as a separate phenomenon of the motivational processes. Some researchers suggest that the frustration of these needs would be more detrimental than low need fulfilment (Vansteenkiste and Ryan, 2013). Future studies need to take into account of need frustration and need dissatisfaction.

In summary, the findings of the current study provide support to the propositions of SDT and add some insights to the differential effects of the three psychological needs. Specifically, need satisfaction enhances autonomous motivation and is linked to positive outcomes. Out of the three psychological needs, need for relatedness seems to be the largest predictor of autonomous motivation, compared to needs for autonomy and competence. It is hoped that more studies will be conducted in the future to tease out the effects of the three psychological needs, whether they are additive, synergistic, or balance in education and other settings. Dysvik and his colleagues (Dysvik et al., 2013) suggest the presence of additive, synergistic, but not balanced effects of need satisfaction on intrinsic motivation in the work domain.

Declarations

Author contribution statement

John Wang: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Woon Chia Liu: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Ying Hwa Kee: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

Lit Khoon Chian: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

Competing interest statement

Additional information

No additional information is available for this paper.

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References

Bentler, P.M., 1995. EQS Structural Equations Program Manual. Multivariate Software, Encino, CA.

Browne, M.W., Cudeck, R., 1992. Alternative ways of assessing model fit. In: Bollen, K.A., Long, J.S.J.S. (Eds.), Testing Structural Equation Models. Sage, Beverly Hills, CA, pp. 230–258.

Byrne, B.M., 2006. Structural Equation Modeling with EQS: Basic Concepts, Applications and Programming, second ed. Lawrence Erlbaum Associates, Mahwah, New Jersey.

Connell, J.P., Wellborn, J.G., 1991. Competence, autonomy, and relatedness: a motivational analysis of self-system processes. In: Gunnar, M.R., Sroufe, L.A. (Eds.), Self Processes and Development: the Minnesota Symposia on Child Development, 23. Erlbaum, Hillsdale, NJ, pp. 43–78.

Deci, E.L., Ryan, R.M., 1985. Intrinsic Motivation and Self-Determination in Human Behavior. Plenum Press, New York.

Deci, E.L., Ryan, R.M., 1991. A motivational approach to self: integration in personality. In: Dienstbier, R. (Ed.), Nebraska Symposium on Motivation. University of Nebraska Press, Lincoln, NE, pp. 237–288.

Deci, E.L., Ryan, R.M., 1994. Promoting self-determined education. Scand. J. Educ. Res. 38 (1), 3–14.

Deci, E.L., Ryan, R.M., 2000. The "what" and "why" of goal pursuits: human needs and the self-determination of behavior. Psychol. Inq. 11 (4), 227–268.

Deci, E.L., Eghrari, H., Patrick, B.C., Leone, D.R., 1994. Facilitating internalization: the self-determination theory perspective. J. Personal. 62, 119–142.

Dysvik, A., Kuvaas, B., Gagne, M., 2013. An investigation of the unique, synergistic and balanced relationships between basic psychological needs and intrinsic motivation. J. Appl. Soc. Psychol. 43 (5), 1050–1064.

Goudas, M., Biddle, S., Fox, K., 1994. Achievement goal orientations and intrinsic motivation in physical fitness testing with children. Pediatr. Exerc. Sci. 6, 159–167.

Grolnick, W.S., Ryan, R.M., Deci, E.L., 1991. Inner resources for school-achievement-motivational mediators of childrens perceptions of their parents. J. Educ. Psychol. 83 (4), 508–517.

Hu, L., Bentler, P.M., 1999. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. Struct. Equ. Model. 6, 1–55.

Kline, R.B., 2005. Methodology in the Social Sciences: Principles and Practice of Structural Equation Modeling, 2 ed. Guilford Press, New York, NY.

Koestner, R., Ryan, R.M., Bernieri, F., Holt, K., 1984. Setting limits on childrens behavior - the differential-effects of controlling vs informational styles on intrinsic motivation and creativity. J. Personal. 52 (3), 233–248.

Liu, W.C., Wang, C.K.J., Kee, Y.H., Koh, C., Lim, B.S.C., Chua, L.L., 2014. College students' motivation and learning strategies profiles and academic achievement: a self-determination theory approach. Educ. Psychol. 34 (3), 338–353.

McAuley, E., Duncan, T.E., Tammen, V.V., 1989. Psychometric properties of the Intrinsic Motivation Inventory in a competitive sport setting: a confirmatory factor analysis. Res. Q. Exerc. Sport 60, 48–58.

Milyavskaya, M., Koestner, R., 2011. Psychological needs, motivation, and well-being: a test of self-determination theory across multiple domains. Pers. Indiv. Differ. 50, 387–391.

Ministry of Education, 2017. The Singapore Teaching Practice. Retrieved 19 Nov 2018. https://www.moe.gov.sg/about/singapore-teaching-practice.

Muthén, L.K., Muthén, B.O., 2014. Mplus User's Guide, seventh ed. Muthén & Muthén, Los Angeles, CA.

National Centre for Education Statistics, 2016. Trends in International Mathematics and Science Study (TIMSS). Retrieved from. https://nces.ed.gov/timss/.

Ng, C.M., 2017. Ministry of Education FY 2017 Committee of Supply Debate Speech by Minister of Education (Schools). Retrieved 19 Nov 2018. https://www.moe.gov.sg/news/speeches/moe-fy-2017-committee-of-supply-debate-speech-by-minister-of-education-schools-ng-chee-meng.

Niemiec, C.P., Ryan, R.M., 2009. Autonomy, competence, and relatedness in the classroom applying self-determination theory to educational practice. Theor. Res. Educ. 7, 133–144.

OECD, 2015. Education at a Glance 2015: OECD Indicators. Retrieved from. http://www.oecd.org/edu/education-at-a-glance-2015.htm.

Reeve, J., 2009. Why teachers adopt a controlling motivating style toward students and how they can become more autonomy supportive. Educ. Psychol. 44, 159–178.

Ryan, R.M., Deci, E.L., 2000. Self-determination theory and the facilitation of intrinsic motivation, social development and well-being. Am. Psychol. 55 (1), 68–78.

Ryan, R.M., Deci, E.L., 2017. Self-deteremination Theory: Basic Psychological Needs in Motivation, Development, and Wellness. The Guilford Press, New York.

Sheldon, K.M., Filak, V., 2008. Manipulating autonomy, competence, and relatedness support in a game-learning context: new evidence that all three needs matter. Br. J. Soc. Psychol. 47, 267–283.

Sheldon, K.M., Ryan, R.M., Deci, E.L., Kasser, T., 2004. The independent effects of goal contents and motives on well-being: it's both what you pursue and why you pursue it. Pers. Soc. Psychol. Bull. 30, 475–486.

Standage, M., Duda, J.L., Ntoumanis, N., 2005. A test of self-determination theory in school physical education. Br. J. Educ. Psychol. 75, 411–433.

Taylor, I., Ntoumanis, N., 2007. Teacher motivational strategies and student self-determination in physical education. J. Educ. Psychol. 99, 747–760.

Vallerand, R.J., Losier, G.F., 1999. An integrative analysis of intrinsic and extrinsic motivation in sport. J. Appl. Sport Psychol. 11, 142–169.

Vallerand, R.J., Pelletier, L.G., Blais, M.R., Brière, N.M., Senecal, C., Vallieres, E.F., 1993. On the assessment of intrinsic, extrinsic, and amotivation in education: evidence on the concurrent and construct validity of the Academic Motivation Scale. Educ. Psychol. Meas. 53, 159–172.

Vallerand, R.J., Fortier, M.S., Guay, F., 1997. Self-determination and persistence in a real-life setting: toward a motivational model of high school dropout. J. Personal. Soc. Psychol. 72, 1161–1176.

Vansteenkiste, M., Ryan, R.M., 2013. On psychological growth and vulnerability: basic psychological need satisfaction and need frustration as a unifying principle. J. Psychother. Integr. 23, 263–280.

Vansteenkiste, M., Simons, J., Lens, W., Sheldon, K.M., Deci, E.L., 2004. Motivating learning, performance, and persistence: the synergistic effects of intrinsic goal contents and autonomy-supportive contexts. J. Personal. Soc. Psychol. 87 (2), 246–260.

Wang, C.K.J., 2017. The joy of learning: what is it and how to achieve it. Exchange 1, 7–11.

Wang, C.K.J., Liu, W.C., Nie, Y., Chye, S., Liem, G.A., Lim, B.S.C., et al., 2017. Latent profile analysis of students' motivation and outcomes in Mathematics: an organismic integration theory perspective. Heliyon 3 (5), e00308.

Zuroff, D.C., Koestner, R., Moskowitz, D.S., McBride, C., Marshall, M.S., Bagby, R.M., 2007. Autonomous motivation for therapy: a new common factor in brief treatments of depression. Psychother. Res. 17, 137–148.