The tripartite model of intrinsic motivation in education: A 30-year retrospective and meta-analysis

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Abstract

Overview: Intrinsic motivation is a well-established concept in psychology, yet different types of intrinsic motivation have not been thoroughly investigated. We examined covariates associated with three types of intrinsic motivation from self-determination theory within the education context: IM to know, IM to accomplish, and IM to experience stimulation.

Method: A meta-analysis was conducted on samples examining the tripartite model of intrinsic motivation between 1989-2019. In total, 78 samples met the inclusion criteria, representing 41,633 participants across multiple nationalities. The average age of participants across samples was 19 years, and 58.2% of participants were female. Path analysis and relative weight analysis were applied to meta-analytically derived correlations.

Results: Results indicated that IM to know and IM to accomplish were moderately strong predictors of adaptive student outcomes. However, results also indicated a large degree of redundancy including indistinguishable antecedent pathways. IM to experience stimulation was positively, yet less strongly associated with adaptive outcomes. However, it did appear to be empirically distinct from the remaining intrinsic motivation types in respect to its outcomes and antecedents.

Conclusion: Intrinsic motivation appears to be a relatively homogeneous construct within educational psychology. Specification of different types of intrinsic motivation is likely to provide only marginal benefit.

Keywords: intrinsic motivation; tripartite model; meta-analysis; self-determination theory.

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Introduction

Intrinsic motivation is a well-known and well-researched concept. From infancy, humans demonstrate an innate drive towards situations and behaviors that provide excitement, novelty, and joy. Research has clearly demonstrated that intrinsic motivation, defined as engaging in an activity for its own sake because it is inherently interesting or enjoyable, is a powerful force shaping human behavior (Ryan & Deci, 2017) across all ages, cultures (Chirkov, 2009), and multiple domains of life (Cerasoli, Nicklin, & Ford, 2014; Ng et al., 2012; Vasconcellos et al., 2019). This is contrasted against extrinsic motivation which is driven by external contingencies and refers to engaging in a behavior because it leads to outcomes separable from the behavior itself such as rewards, punishment, ego-involved feelings of pride or shame, or even the perceived utility or meaningfulness of a behaviors' outcome (Ryan & Deci, 2000, 2017). Self-determination theory expands upon this intrinsic/extrinsic dichotomy to specify nuanced types of motivation based upon strong theoretical and empirical evidence. Furthermore, through a process of internalization, the satisfaction of basic psychological needs for autonomy, competence, and relatedness will determine the type of motivation experienced (Ryan & Deci, 2017). For example, individuals subject to low levels of need satisfaction in a setting will experience extrinsic forms of motivation (i.e. external and introjected motivations) and are expected to report poorer outcomes (e.g., burnout and stress; Deci & Ryan, 2000). Alternately, individuals subject to high levels of need satisfaction will experience identified and intrinsic motivation, which in turn produce positive outcomes (e.g., performance and wellbeing; Deci & Ryan, 2000).

A wide body of research and several meta-analyses have investigated the relative effects of different types of extrinsic motivation (see Ng et al., 2012; Owen, Smith, Lubans, Ng, & Lonsdale, 2014; Vasconcellos et al., 2019), with much of this research centered on students and educational contexts. For example, the earliest and most widely used scales are those designed for use in education settings (Vallerand, Blais, Brière, & Pelletier, 1989). While these scales all measured the various types of extrinsic motivation, some also distinguished facets of intrinsic motivation. However, despite this, far less attention has been given to different types of intrinsic motivation (Carbonneau, Vallerand, & Lafrenière, 2012; Vallerand, Blais, Brière, & Pelletier, 1989).

Vallerand and colleagues (Vallerand et al., 1989) were among the first to conceptualize different types of intrinsic motivation, specifying three distinct types: intrinsic motivation to know (IM-know), intrinsic motivation to accomplish (IM-accomplish), and intrinsic motivation to experience stimulation (IM-stimulation). It was proposed that not only are these types of intrinsic motivation theoretically different, they are also empirically discernable and associate with different outcomes. However, despite the 30-year history of these concepts, they have undergone limited theoretical development, been subject to many uninformative validation studies and, likely as a result, have been used sparingly in the literature. This paper presents a meta-analytic investigation of the three types of intrinsic motivation in order to examine how these subscales have been used and their unique contribute to our understanding of motivation.

Intrinsic Motivation Dimensions

Broadly, intrinsic motivation refers to engaging in a behavior or activity for its own sake and for the enjoyment, pleasure, and satisfaction derived from participation (Deci, 1971; Ryan & Deci, 2017). However, many researchers from differing theoretical backgrounds have questioned

the homogeneous nature of intrinsic motivation, instead arguing that meaningful difference can be made between types of intrinsic motivation (e.g. Reeve, 1989). Firstly, IM-know is characterized by engagement in an activity for the pleasure and fulfillment one experiences while "learning, exploring or trying to understand something new" (Vallerand et al., 1992, p. 1005). Students who are intrinsically motivated to know are, for example, driven to study a textbook for the pleasure they experience while learning the new material. As previous research has noted, concepts highly similar to IM-know have been widely discussed in the education literature, such as learning goals (Dweck, 1986) and intrinsic curiosity (Harter, 1981). Secondly, IM-accomplish is defined by the engagement in a behavior due to the pleasure and fulfillment experienced when an individual "tries to accomplish or create something" (Vallerand et al., 1992, p. 1005). Importantly, students who are intrinsically motivated to accomplish things derive a sense of satisfaction from the process of achieving rather than from the rewards obtained through the achievement. This type of intrinsic motivation aligns with similar motivational constructs such as mastery motivation (Harter, 1981) and need for achievement (McClelland, 1961). Lastly, IM-stimulation is defined as engaging in an activity "in order to experience stimulating sensations" (Vallerand et al., 1992, p.1006), for example, aesthetic experiences, fun, and excitement. This type of intrinsic motivation has been likened to the concept of flow (Csikszentmihalyi, 2000).

Since the development and initial validation of the Academic Motivation Scale (Vallerand et al., 1989) in which these intrinsic motivation subscales were first proposed, many further validation studies have been conducted with varying degrees of rigor. Specifically, we were able to identify 39 further studies, across 46 samples, claiming to validate the academic motivation scale, typically in new languages or specific educational contexts. This would appear to indicate a strong degree of validity for this scale and the tripartite model of intrinsic

motivation. However, examination of these samples indicates a less clear conclusion. Of these, 14 did not find support for the inclusion of intrinsic motivation subscales, instead concluding that correlations between subscales were too great to justify their differentiation, and instead recommended combining them into a general intrinsic motivation factor. The remaining 32 samples supported the validity of the intrinsic motivation subscales. However, it is worth noting that only 15 of these samples included covariates, with the remaining 17 samples relying on measurement models as the sole indicators of validity. As such, most studies that claim to validate this nuanced distinction between intrinsic motivation types were unable to test the utility of the subscales. Furthermore, most studies examining covariates of the intrinsic motivation subscales examined only whether subscales related to covariates yet did not examine whether there are differences between how the subscales relate to these covariates. For example, while the original development and validation study by Vallerand and colleagues (1989) stands as one of the strongest pieces of evidence supporting the distinction between intrinsic motivation subscales, the results do not indicate clear differences between IM-know and IM-accomplish. When examining correlations with seven covariates, the largest difference between these two subscales is small (Δ_r =.06; $M_{\Delta r}$ = .03). Examining predictive validity also tends toward similar results (e.g. Vallerand et al., 1992, 1993). As such, the validity, and the practical utility of the tripartite model of intrinsic motivation remains debatable despite its history.

Carbonneau and colleagues (2012) sought to address these construct validity issues in a multi-sample study. The authors specified four propositions which they argued needed to be met in order to confirm the tripartite model of intrinsic motivation. First, it was proposed that intrinsic motivation can be seen as a multidimensional construct. Carbonneau and colleagues

(2012), as well as other validation studies, support this proposition through factor analysis and correlations between subscales that reject unidimensionality.

Second, intrinsic motivation subscales ought to behave similarly to the broader intrinsic motivation construct. This proposition again appears validated by past research that not only finds intrinsic motivation subscales to behave similarly to a general intrinsic motivation scale (Pelletier et al., 1995; Vallerand et al., 1989, 1992, 1993), but in fact are often combined to form just such a measure (e.g. Boiché, Sarrazin, Grouzet, Pelletier, & Chanal, 2008; Lim & Chapman, 2015; Ntoumanis, Barkoukis & Thøgersen-Ntoumani, 2009; Otis, Grouzet, Pelletier, 2005). A meta-analysis examining correlations between types of motivation across scales and domains also supported Carbonneau and colleagues' second proposition, finding that intrinsic motivation subscales occupied a similar theoretical space as general intrinsic motivation through multidimensional scaling (Howard, Gagné, & Bureau, 2017).

The third and fourth propositions put forward by Carbonneau and colleagues concerned how intrinsic motivation subscales relate to covariates. Proposition 3 detailed that each intrinsic motivation subscale should have specific antecedents which are related to one subscale and not others, whereas proposition 4 stated that each intrinsic motivation subscale should have specific outcomes which it is able to predict better than other intrinsic motivation subscales. Through four studies, Carbonneau and colleagues (2012) found support for both propositions, most interestingly finding that personality elements were found to predict different types of intrinsic motivation, and that intrinsic motivation subscales subsequently related differently to affective states and behavioral choices. Specifically, they found that curiosity-oriented personality correlated more strongly with IM-know than other intrinsic motivation subscales, achievement-oriented personality related to IM-accomplish, and sensation-oriented personality related more

strongly to IM-stimulation. Additionally, they found that IM-know positively related to affective states characterized by curiosity and attentiveness, IM-accomplish related positively to feelings of being skilled and proud, and IM-stimulation positively associated to affective states of excitement and of being entertained.

Carbonneau and colleagues' (2012) results supported their propositions and, accordingly, the tripartite model of intrinsic motivation. However, while their study represents the strongest validation of this tripartite model of intrinsic motivation to date, the approach of matching intrinsic motivation subscales with closely worded covariates through self-report measures at a single time point lacks generalizability. In other words, these results successfully demonstrate a proof of concept, but the practical utility of this model is yet to be supported. To demonstrate the practical utility and general validity of the tripartite model of intrinsic motivation, these propositions need to be revisited in a broader education context. As such, in line with propositions 1 and 2 from Carbonneau and colleagues, we first propose the following hypotheses.

H1: We expect intrinsic motivation subscales to be distinguishable from one another as indicated by inter-factor correlations.

H2: We expect intrinsic motivation subscale to positively associate with desirable covariates, and negatively with undesirable covariates, and to a similar degree to general intrinsic motivation.

Predictors of Intrinsic Motivation

The tripartite model of intrinsic motivation is a sub-theory within self-determination theory, which posits that the satisfaction of three basic psychological needs of autonomy, competence, and relatedness are primary antecedents of motivation (Deci & Ryan, 2000). These

needs are in turn facilitated by autonomy support, which includes practices such as providing rationales, demonstrating empathy, and using facilitative rather than controlling language from those surrounding the individual, most notably teachers and parents (Vasquez, Patall, Fong, Corrigan, & Pine, 2016). This mediational pathway from autonomy support to motivation, through individual need satisfaction, is well established in commonly studied motivation types including external, introjected, identified regulation and broadly defined intrinsic motivation (Slemp, Kern, Patrick, & Ryan, 2018; Vansteenkiste, Ryan, & Soenens, 2020). While previous research has demonstrated that psychological needs and autonomy support are positively correlated with the three intrinsic motivation subscales (Vallerand et al., 1989, 1993), however, ideally these established antecedents should also demonstrate differential predictive capability. That is, if identified antecedents result in increased levels of all three intrinsic motivation variables yet do not distinguish between them, the practical utility of the tripartite model of intrinsic motivation can be called into question. There is currently no theoretical guidance on how these associations should look. This is problematic and highlights that the core tenets of the theory provide no theoretical nor empirical guideline regarding how or when one type of intrinsic motivation will emerge over another. To strengthen the case of a tripartite model of intrinsic motivation (proposition 3; Carbonneau et al., 2012), we propose the following hypothesis:

H3: Theoretical predictors will relate differently to each intrinsic motivation subscale, indicating different psychological pathways to each type of intrinsic motivation.

Outcomes of Intrinsic Motivation

Proposition 2 from Carbonneau and colleagues (2012) implies that intrinsic motivation types should globally predict outcomes following similar associative patterns as general intrinsic motivation. However, the general applicability of the tripartite models of intrinsic motivation

also requires subscales to predict outcomes differentially to some extent (proposition 4, Carbonneau et al., 2012). Put differently, if each type of intrinsic motivation relates to outcomes in an identical manner, the utility and predictive validity of the tripartite model would not be supported. In the current literature, this element of unique predictive validity is an essential, yet largely missing, indicator of validity. Accordingly, we propose the following hypothesis.

H4: The three intrinsic motivation subscales will relate to different outcomes, or the same outcomes to different degrees, indicating the different functionalities of each subscale.

Moderators

Finally, we examined both theoretical and methodological moderators. While a broad range of potential moderators were coded, age and gender were the only theoretical moderators reported often enough to conduct robust analyses. SDT posits that motivation is a universal and consistent construct across demographic variables including age and gender (Ryan & Deci, 2017; Vansteenkiste, Ryan, & Soenens, 2020), however we nonetheless tested these factors in an exploratory manner as meta-analysis is an efficient tool to test such global hypotheses. We also conducted several tests to examine the methodological moderating effects of publication status (i.e. published vs. unpublished results) to determine if and to what extent publication bias may be present (Ferguson & Brannick, 2012; McAuley, Tugwell, & Moher, 2000).

The Current Study

The current study attempts to verify the tripartite model of intrinsic motivation (see Figure 1) through meta-analytic examination of intrinsic motivation subscales in the educational psychological literature. We limit our scope to the education context primarily because of the model's history in the area. The initial conceptualization of the tripartite model was developed in the education context as reflected by the scale items (Vallerand et al., 1992) as well as the

concepts themselves (i.e., IM-know). As a result, a large proportion of the literature surrounding these types of intrinsic motivation falls into this context, further resulting in a higher density of studies examining education focused outcomes which is necessary for meta-analysis. Additionally, the meta-analytic approach was selected as it allows us to identify how intrinsic motivation subscales relate to a broad array of commonly studied education-focused outcomes. This is important in order to assess the utility of these concepts in generalized research contexts. Specifically, we address the four propositions outlined by Carbonneau (2012) concerning 1) the degree to which intrinsic motivation subscales can be seen as multidimensional as assessed through inter-factor correlations, 2) whether intrinsic motivation subscales behave in a similar fashion to the known concept of general intrinsic motivation, 3) whether antecedents of intrinsic motivation subscales vary, and 4) whether outcomes associated with each subscale vary. As such, we apply a meta-analytic approach in order to first summarize what is known about the tripartite model of IM within the education literature and, second, to examine the validity of such an approach to a generalized education context based upon 30 years of past research.

Methods

Inclusion Criteria

Samples had to meet three inclusion criteria to be included in the current meta-analysis. First, given our focus on student motivation, samples had to have been collected from students in an education context. All students from primary school to university, inclusive, were eligible. Second, given the variables of central interest are only measured by three scales, the Academic Motivation Scale (Vallerand et al., 1989), The Behavioral Regulation in Sport Questionnaire (BRSQ; Lonsdale, Hodge & Roses, 2008), and the Sports Motivation Scale (Pelletier, Tuson, Fortier, Vallerand, Brière, & Blais, 1995), samples were required to use one of these validated

scales to be eligible for inclusion. Lastly, samples had to contain correlations between at least one type of intrinsic motivation and a covariate.

Literature Search

The literature search procedure relied on three methods. Forward searches were conducted beginning with the validation studies for each of the scales (i.e. Lonsdale, Hodge & Roses, 2008; Pelletier et al., 1995; Vallerand et al., 1989, 1992). This search was conducted through Google Scholar and Web of Science by all three authors. Second, a database search was conducted in order to identify any studies not captured by the forward search. This search was conducted in conjunction with a larger project examining all types of motivation specified with self-determination theory. This involved searching the PsycINFO, EBSCO, and Proquest Dissertation and Thesis Global databases with the keywords "self-determination" and "student" as well as additional searches using the scale names (i.e. academic motivation scale, AMS, sports motivation scale, SMS, behavioral regulation in sport questionnaire, BRSQ) and "student" as keywords. All grey literature including dissertations, theses, and conference proceedings were included throughout all searches. Finally, we advertised for data through several mailing lists associated with active motivation research communities, specifically the American Educational Research Association, Society of Personality and Social Psychology, and Society for the Study of Motivation, and the Self-Determination Theory mailing lists.

Our final database consisted of 78 samples including 58 published and 20 unpublished samples. A total of 594 correlation coefficients were analyzed with data from 41,633 participants (ranging from 47 – 4,498 participants, mean = 534). The mean age across samples was 19 years and the average proportion of females in each sample was 58.2%.

Coding

All studies collected through the literature search were coded by either the first or second author. We coded for the type of motivation studied, the scale used, reliability of the scale in the sample, source of data (self or other reported), covariate measured, scale used to assess covariate, the associated reliability, and source of covariate rating (self or other), as well as sample size and correlation. Finally, demographic variables including domain (classroom education or physical education), country of data collection, language, publication status, study design (cross-sectional, longitudinal, time lag, or experimental), mean age, and proportion of males within the sample were all coded. All outcome variables available in collected studies were coded, though eligibility for analyses required that each outcome was reported in at least three samples.

Meta-Analytic Procedures

All analyses were conducted with the robumeta package within the R software (Fisher & Tipton, 2015) applying random effects models (Hunter & Schmidt, 2000; Schmidt & Hunter, 2014). Robust variance estimator was used to handle non-independence of samples (Fisher & Tipton, 2015). Prior to analyses, mean reliability scores were calculated for each variable (see Table S4) and imputed when reliability data was missing in a study. Potential outliers and influential cases were examined through cumulative analysis and one-study-removed analyses (Borenstein, Hedges, Higgins, & Rothstein, 2011), which found no study to substantially influence results. As such, no cases were removed.

Corrections for reliability were applied prior to estimating the final meta-analytic correlations (ρ) through inverse-variance weighting procedures. The 95% confidence intervals associated with point estimates were reported alongside the number of samples included in each analysis (k), the standard error of each estimate, and heterogeneity statistics of Tau-squared (T^2) and the I^2 statistic. T^2 indicates the degree of heterogeneity present. I^2 indicates the proportion of

this heterogeneity potentially associated with true moderating variables, as opposed to measurement error and stochasticity, for example. When comparing correlations for significant differences, significance was determined by the degree of overlap between confidence intervals. Specifically, 95% confidence intervals that overlapped less than 50% were indicative of meaningful differences (Cumming & Finch, 2005).

Age and gender (operationalized as mean age and proportion of males in a sample, respectively) were tested as potential moderating influences through meta-regression. Meta-regression examines the between-study variance in an effect and attempts to explain this through incorporation of continuous variables. This analysis produces a regression coefficient which estimates the degree to which a point estimate will vary following a one-point increase in the moderating variable, as well as the probability associated with this coefficient, and an estimated R^2 associated with the moderator. Finally, publication bias was assessed through trim and fill procedures (Duval & Tweedie, 2000), Egger's test of the intercept (Egger, Smith, Schneider, & Minder, 1997), and subgroup analysis. Trim and fill analyses utilize funnel plots to identify potentially missing studies based upon the distribution of point estimates, with the assumption that missing studies indicate collected but unpublished samples, that is, publication bias. Results of this analysis indicate the number of studies estimated to be missing and a corrected estimate indicates the influence these missing studies would likely have. Egger's test examines the symmetry of the funnel plot though through regression-based tests with significant results indicating publication bias. Subgroup analyses were conducted to directly compare results from published and unpublished samples. If substantial publication bias is present, differences would be noted between these groups, with published samples typically expected to display more extreme results and unpublished samples containing more insignificant findings.

Finally, we conducted path analysis to test predictive pathways associated with intrinsic motivation types (H3), and a combination of path analysis and relative weight analysis to examine their predictive validity (H4). Path analysis is a regression-based method through which to test causal pathways and competing models from a correlation matrix. This method is particularly well suited to meta-analytic studies in which only a global correlation matrix is available, since SEM cannot be applied (Slemp et al., 2018; Viswesvaran & Ones, 1995). In this study, path analysis was used to test the competing pathways through which autonomy support and basic psychological needs predict intrinsic motivation types. While path analysis is not a new methodology (Viswesvaran & Ones, 1995), it remains an important, and often underutilized method for theory testing in meta-analysis beyond simple examination of correlation matrices (Hagger, Chan, Protogerou, & Chatzisarantis, 2016). Meta-analytic SEM is an increasingly popular method for testing similar research questions through more advanced SEM-based procedures. However, we could not conduct meta-analytic SEM because correlations between the three needs of autonomy, competence, and relatedness, as well as the correlations between these needs and autonomy support were not regularly reported in the gathered samples. Instead, to run a path analysis these correlations were drawn from another meta-analysis (Bureau, Howard, Chong, & Guay, 2020) specifically examining these relationships across the wider context of education research, as commonly practiced (see Viswesvaran & Ones, 1995). On average, 32 samples (min = 7, max = 58) were used to calculate each of these imported meta-analytic correlations.

When attempting to estimate the relationships between intrinsic motivation subscales and outcomes through path analysis, the very high correlations between intrinsic motivation subscales raised serious concerns about multicollinearity. In order to address this, we

complemented our analyses with relative weight analysis (RWA; Tonidandel & LeBreton, 2011, 2015). RWA involves a series of regression analyses that control for multicollinearity, and thereby provides a more accurate estimate of the contribution each predictor makes in explaining variance in an outcome (Johnson & LeBreton, 2004). In this case, RWA tests the relative contribution of each IM subscale in explaining predicted variance in outcomes. Specifically, based upon a correlation table, RWA creates a new set of orthogonal predictors (in this case intrinsic motivation subscales), as similar as possible to the original. The outcome variable is then regressed onto these new orthogonal predictors, yielding a standardized regression coefficient that, when squared, represents the relation between the proxy and the outcome, free from multicollinearity. The original predictors are then regressed onto the new orthogonal predictors (Johnson, 2000). By combining the estimates obtained from regressing the outcomes onto the orthogonal predictors with the estimates obtained from regressing the original predictors onto the new proxies, the relative weight of the original predictors can be calculated (Lundby & Johnson, 2006). The result is an estimate of the individual contribution each subscale makes towards predicting explained variance in the outcome variable after taking multicollinearity into account, expressed as a percentage of the total R^2 attributed uniquely to each predictor.

Results

Construct Validity

Our first hypothesis (i.e., construct validity through intercorrelations) was answered through examination of correlations between intrinsic motivation subscales (Table 1). These high correlations, ranging from .83 to .86, are evidence that these variables are extremely similar and approaching unity. However, given these results are drawn from many studies (k = 61-62), we can also be confident that they are not the exact same variable, with around 30% of non-

overlapping variance. However, with this degree of overlap, strong predictive and explanatory validity is required to demonstrate the usefulness of different intrinsic motivation subscales.

Antecedents to Intrinsic Motivation

Our second and third hypotheses can be addressed through examination of correlations between intrinsic subscales and known antecedents (Table 2). For all covariates considered as antecedents (i.e. autonomy support, satisfaction of autonomy, competence, and relatedness needs), each type of intrinsic motivation was found to correlate moderately and positively. Relationships with autonomy ranged from .41 to .45 (k = 9), and no significant differences were noted between the three intrinsic motivation subscales. Competence related to intrinsic subscales between .38 and .48 (k = 10-11). Confidence intervals indicated that intrinsic motivation to know and to experience stimulation differently related to the need for competence, though this difference was minor. Relatedness was associated with all three types of intrinsic motivation moderately and positively (ρ = .38 to .44; k = 6), and no differences were noted. Likewise, no differences were noted in associations between intrinsic subscales and perceived autonomy support (ρ = .26 to .31; k = 6-7). These results indicate that known antecedents of motivation, as theorized by SDT, do not differentially correlate with the three intrinsic motivation subscales. It is also worth noting that a previous meta-analysis of self-determination theory in education (Vasconcellos et al., 2019) found that general intrinsic motivation related to autonomy support (ρ = .52, k = 25), autonomy satisfaction (ρ = .61, k = 33), competence (ρ = .62, k = 33), and relatedness (ρ = .55, k = 53) more strongly than the intrinsic subscales in the current study.

Path Analysis. When examining antecedents of IM-know (see Table 3), results indicated that the needs were directly related to this type of intrinsic motivation as demonstrated by weak associations with autonomy and relatedness (β = .13 & .14 respectively), and a moderate positive

association with competence (β = .28). While autonomy support did not directly predict IM-know, indirect effects from autonomy support to IM-know were present through each of the needs. These indirect effects through autonomy and relatedness were weak (β = .08 in both cases), while the pathway from autonomy support to IM-know through competence was somewhat stronger (β = .13). These results were mirrored in relation to IM-accomplish. The three needs were significant and positive predictors of IM-accomplish, though competence was again the strongest (β = .30). Autonomy support also did not directly relate to IM-accomplish, with psychological needs fully mediating this relationship. Specifically, autonomy and relatedness represented small yet significant pathways from autonomy support to IM-accomplish (β = .07 & .05 respectively), whereas competence proved the most influential mediator, with the indirect effect from autonomy support to IM-accomplish through competence estimated at .14.

The pathways from autonomy support to IM-stimulation were found to be somewhat different. The three psychological needs all predicted IM-stimulation positively with competence the weakest (β = .06), followed by autonomy (β = .22), and relatedness (β = .30). Autonomy support significantly and negatively predicted IM-stimulation (β = -.06). Weak yet significant indirect effects of autonomy support through psychological needs of autonomy (β = .14), relatedness (β = .16) and competence (β = .03), were also identified. Results therefore indicate that the pathways from predictors to IM-stimulation are somewhat different from those leading to IM-know and IM-accomplish, which were near identical. That is, competence was found to be the key predictor and mediator when predicting IM-know and IM-accomplish, whereas autonomy and relatedness were key antecedents of IM-Stimulation.

Outcomes of Intrinsic Motivation

Our fourth hypothesis (i.e., criterion validity through differential outcome prediction) was first informed by Tables 4 and 5. Beginning with a broad overview, two notable patterns were evident. First, each intrinsic subscale related to outcomes in a very similar manner, always in the same direction, and with highly similar effect sizes. Second, despite this, there was also evidence that IM-know consistently correlated more highly with outcomes than IM-stimulation, while generally IM-accomplish fell between these two.

GPA. When examining outcomes individually, and beginning with GPA, results showed a significant difference between IM-stimulation and both IM-know and IM-accomplish. IM-stimulation did not associate significantly with either self-report or objectively measured GPA, whereas both IM-know and IM-accomplish did. It is also interesting to note that, while not significantly different, IM-accomplish correlated more highly with self-reported GPA ($\rho = .16$; $k = 10$) than IM-know ($\rho = .12$; $k = 11$), whereas the opposite was true for objective GPA for which IM-know related more strongly ($\rho = .17$; $k = 19$) than IM- accomplish ($\rho = .13$; $k = 16$).

Well-being. Indicators of well-being, specifically positive affect ($k = 7$-8) and satisfaction ($k = 8$-9), each related moderately and significantly with the intrinsic motivation subscales. No significant differences were noted between intrinsic motivation types. This same pattern was evident for engagement ($k = 7$), for which each intrinsic motivation subscale was equally and positively related ($\rho = .32$ to $.41$). The two indicators of negative well-being, negative affect ($k = 7$-8) and anxiety ($k = 6$-7), displayed a small though significant difference between intrinsic subscales. While each subscale related similarly and negatively to both negative affect ($\rho = -.08$ to $-.15$) and anxiety ($\rho = -.08$ to $-.15$), IM-know was the only one significantly related to these outcomes.

Self-Efficacy. Relationships between self-efficacy and intrinsic subscales indicate some significant differences. Specifically, self-efficacy related to IM-know (ρ = .42; k = 10) more strongly, and significantly differently to either IM-accomplish (ρ = .35; k = 10) or IM-stimulation (ρ = 31; k = 11). Additionally, while overall effect size was very similar, results indicated that the difference between IM- accomplish and IM-stimulation was significant.

Goal Orientation. As seen in Table 5, results indicated no significant relationships between intrinsic motivation subscales and either mastery-avoidance or performance-avoidance variables. Alternately, all three intrinsic subscales related moderately and significantly to mastery-approach goals. IM-accomplish related significantly more strongly to this outcome (ρ = .29; k = 5) than either IM-know (ρ = 17; k = 5) or IM-stimulation (ρ = 19; k = 5). When examining performance-approach, both IM-know (ρ = 54; k = 5) and IM- accomplish (ρ = 52; k = 5) related significantly more strongly to it than IM-stimulation (ρ = 41; k = 5).

Path & Relative Weight Analysis. Path analysis of outcome variables proved ineffective due to the very high levels of multicollinearity present between intrinsic motivation subscales (Table 6). Specifically, path analysis results would suggest that IM-know positively predicts a range of outcomes including GPA, positive affect, and engagement, while IM-stimulation negatively predicts these same outcomes. For example, IM-stimulation was estimated to negatively predict GPA (self- and objectively reported), positive affect, engagement, self-efficacy, mastery-approach, and performance-approach, despite reporting positive correlations with each of these variables. Alternately, IM-stimulation was also estimated to positively, and significantly, predict negative affect and anxiety despite correlating negatively with both. Given these untrustworthy results stemming from multicollinearity issues, we instead relied primarily upon relative weight analysis to examine criterion validity.

Results of RWA emphasized several important distinctions. First, IM-accomplish appeared a particularly strong predictor of self-report GPA (RW = 48.96%, versus 25.29% for IM-know and 25.75% for IM-stimulation), whereas IM-know was a notably stronger predictor of objectively reported GPA (RW = 55.12%, versus 24.80% for IM-accomplish and 20.08% for IM-stimulation). It should be noted, however, that the effect sizes were very small (R^2 = .06 & .05), limiting the practical importance of this distinction. Additionally, IM-know appeared to be the most influential predictor of negative affect (RW = 62.47%), anxiety (61%), and self-esteem (52.08%). On the other hand, IM-accomplish appeared uniquely capable of predicting a mastery-approach goal orientation (RW = 62.75%). Of the remaining outcomes for which intrinsic motivation predicted a notable amount of variance (i.e. positive affect, satisfaction, engagement, and performance-approach orientation), no single intrinsic motivation subscale was found to contribute to prediction more substantially than another.

Moderation Analyses

Moderation analyses examined the role of age, gender, and publication bias in the current analyses (Table S2). Two minor though interesting patterns became evident when examining the moderating influences of age and gender. First, it was evident that the correlations between competence and each of the intrinsic subscales reduced as student age increased. While these effect sizes were small (β = -.04 to -.07) they were nonetheless significant. secondly, correlations between all three needs and IM-stimulation increased as the proportion of males in a sample increased. This implies that autonomy, competence, and relatedness are more highly correlated to IM-stimulation for males than females. Once again, the effect sizes associated with these effects were very small. It is also noteworthy that this moderating effect was noticed only for IM-stimulation but not for either of the other two types of intrinsic motivation.

Finally, there was evidence for publication bias for associations with objectively reported GPA, autonomy support, and self-esteem. For objectively reported GPA, both trim and fill analysis and Egger's regression test indicated the possibility of missing studies reporting smaller effect sizes and, as such, the current estimates for objective GPA may be overestimated. Subgroup analysis (Table S3) support this possibility with respect to objective GPA, finding that published studies (e.g. IM-know; $\rho = .19$; $k = 10$) typically reported larger effect sizes than unpublished ones ($\rho = .14$, $k = 10$). While indications of publication bias were also present for autonomy support and self-esteem, these cases were minor and corrected estimates indicated that interpretation of results associated with these variables would not change even if suspected missing studies were present.

Discussion

We conducted a meta-analysis examining the tripartite model of intrinsic motivation in the education setting to test the theoretical, empirical, and practical relevance of this distinction. In doing so, we summarized the literature to date and examined important elements of construct validly which are all too often overlooked in past validation studies. Specifically, we tested the four propositions put forward by Carbonneau and colleagues (2012) that are required in order to demonstrate construct validity through four hypotheses.

Our results demonstrated that the intrinsic subscales are very highly correlated, providing only marginal support for H1. However, they each behaved in a similar fashion to the general intrinsic motivation construct in terms of relating similarly to known predictors (autonomy support and need satisfaction) and outcomes, supporting H2. In comparison with correlations between the general intrinsic motivation factor and predictors obtained from a previous meta-analysis, our findings indicated that correlations between the intrinsic motivation subscales and

predictors were smaller in size (Vasconcellos et al., 2019). This potentially indicates that IM as a general factor is more strongly affected by contextual elements (e.g., need support) than specific IM types, making it a more robust component to explain motivation in SDT.

Results further showed that antecedents generally predicted each type of intrinsic motivation similarly providing little support for H3. However, the pathway from autonomy support to IM-stimulation was distinct from the pathways from autonomy support to IM-know and IM-accomplish. IM-know and IM-accomplish were indistinguishable in terms of their antecedents. It is also worth noting that the relationships between basic psychological needs and IM-stimulation were all moderated by gender, such that as the proportion of males in the sample increased, the correlation between needs and IM-stimulation increased. This represents another point of differentiation between IM-stimulation and the remaining intrinsic motivation types.

Small differences were noticed across a range of outcome predictions, demonstrating some degree of predictive distinctiveness and providing some support for H4. It is worth noting that the number of samples across these analyses was relatively modest, typically ranging from 5 to 10 samples included in each analysis. However, given that effect sizes for all associations between IM types and outcomes were in the same direction and differing only by small magnitudes, the practical importance of these differences appear very minor. When differences were noticed, IM-stimulation was typically the subscale demonstrating differences, with IM-know and IM-accomplish performing in a near-identical manner. Therefore, results from both predictors and outcomes of IM types point toward IM-stimulation being a somewhat distinct concept from the remaining two proposed intrinsic motivation types.

While IM-stimulation related less strongly with outcomes included in the current study, there is theoretical support and some evidence to suggest it could be more influential in other

contexts, including sport and exercise (Boiché et al., 2008; Hein, Muur, & Koka, 2004; Pelletier et al., 1995). Our results and this past work indicate that while the overall degree of difference is minor, IM-stimulation can be distinguished from IM-know and IM-accomplish. Yet, the practical implications of this difference in the field of education seem to be limited, especially when weighting the incremental benefits against the impracticality of using the construct, namely the loss in parsimony and high levels of multicollinearity.

The sparse differences between IM-know and IM-accomplish are far more subtle than those noted for IM-stimulation. IM-know and IM-accomplish were both predicted by the same antecedents and with extremely similar effect sizes. Additionally, these types of intrinsic motivation correlated with outcomes in a very similar manner, with only two substantial differences noted in the current outcomes. IM-know was significantly more strongly correlated to self-efficacy when compared against IM-accomplish, and this difference was supported by relative weight analysis (Table 4). Alternately, IM-accomplish predicted mastery-approach more strongly than IM-know. It is also worth noting that IM-know was the only significant predictor of negative affect and anxiety, and relative weight analysis supported this preference for IM-know, indicating that it may be more important in reducing these outcomes in students. However, the overall effect sizes were very similar (negative affect β = -.13 & -.09; anxiety β = -.15 & -.11 respectively), indicating that these differences may not be practically significant. As such, it appears that in an education setting, the empirical and practical distinctions between IM-know and IM-accomplish are minor and difficult to capture.

It is also interesting to note that both IM-know and IM-accomplish were predicted primarily by the psychological need for competence, which was also the primary pathway through which autonomy support influenced student intrinsic motivation. This same conclusion

was drawn by a recent meta-analysis of motivation in physical education examining general intrinsic motivation (Vasconcellos et al., 2019), suggesting that IM-know and IM-accomplish might be the IM types that are more prototypical of general IM, at least in the education context. One novel finding of this study showed that the competence to IM types associations reduced in size as participants aged, meaning that competence was a stronger predictor of IM types in primary or secondary education compared to university students. While the effect size of this moderation was small, it could still have some practical implication, such as a diminished importance of autonomy support for nurturing intrinsic motivation, through competence need satisfaction, in higher education.

According to the meta-analytic results of this study, the tripartite model of intrinsic motivation is partially valid. While very highly correlated (Table 1), the intrinsic motivation types are not completely identical in their antecedents and outcomes. However, while some statistically significant differences were noted, the issue of practical relevance is less clear. The differences were, overall, very small in size which would require large samples to capture reliably and may in practice contribute trivially to our understanding of student functioning. Accordingly, we draw the conclusion that while the tripartite model of intrinsic motivation may be suitable in some highly specific contexts and research designs, in general education research, the distinction will not be appreciable. Instead, we propose that the overarching concept of intrinsic motivation will be a more parsimonious method of achieving highly similar results in nearly all cases. For researchers using motivation scales that include distinct intrinsic motivation types, we recommend either forming a global factor of intrinsic motivation or choosing the most theoretically relevant subfactor.

Limitations and Directions for Future Research

First, we point out the limitations associated with the number of available samples. Analyses with covariates in the current study relied on an average of 7.85 samples per estimation. As a result of these somewhat modest number of samples, we acknowledge that the precision of estimates could be further refined as the literature in this area continues to grow. Likewise, we also note that we were precluded from conducting meta-analytic SEM in the current study due to data limitations. However, we also argue that the current analyses are powerful enough to demonstrate convincing trends, specifically the extremely similar effects associated with IM-know and IM-accomplish, and the under-performance of IM-stimulation in comparison. Accordingly, while we are confident in the current result as they relate to the education context broadly defined, we acknowledge that our analyses are not powerful enough to detect more specific effects associated with various moderating influences.

Additionally, several potential moderators were unable to be tested given the current state of the literature. For example, it is viable that the types of intrinsic motivation perform differently in different school subjects. Given the noted differences associated with sporting contexts, it is reasonable to expect IM-stimulation to be more effective in physical education contexts. Alternately, the possibility remains that further differentiation may exist between IM-know and IM-accomplish when examined in specific subject classes (e.g. math, arts, science, etc.). Current literature does not examine these potentialities in detail.

The current study was also limited to the educational context and examined the tripartite model of intrinsic motivation solely as experienced by students. This is notable as intrinsic motivation types are known to perform differently in different contexts and in relation to different covariates. For example, past research relating to exercise and physical education contexts has found more prominent effects associated with IM-stimulation (Boiché et al., 2008;

Hein, Muur, & Koka, 2004; Pelletier et al., 1995). These effects may vary further over other life contexts. For example, despite our observation that competence is the most impactful predictor of intrinsic motivations in education settings, autonomy has been shown to be the most important predictor of general intrinsic motivation in workplaces (Slemp et al., 2018; Van den Broeck et al., 2016). It could be the case that the prominence of intrinsic motivation types may vary between contexts with, for example, IM-accomplish being more common in workplaces due to the focus on achieving goals and meeting deadlines as opposed to the education context which focuses to a greater degree on learning (i.e. IM-know). However, testing these hypotheses would require scale development as no workplace motivation scale to date has distinguished intrinsic motivation types. In addition to context, there is also evidence to indicate that personality-based variables will distinguish between intrinsic motivation types (Carbonneau et al., 2012; Standage, Duda, & Ntoumanis, 2003), which may imply that inter-individual differences between intrinsic motivation types across contexts could exist. Additionally, it is possible that intrinsic motivation subscales function differently over time with, for example, IM-know facilitating longer lasting results when compared to IM-accomplish. The above factors, while not often theorized about and not studied often enough to be included in the current meta-analysis, may add nuance to the tripartite model of intrinsic motivation. Given scales exist in sport and exercise domains of research meta-analyses of the tripartite model in these contexts may provide useful information regarding contextual differences. Such analyses in other contexts (e.g. work, interpersonal relationships, therapy, etc.) are not currently possible and should be approached with caution given the noted overlap and potential redundancy between constructs noted in this study.

Conclusion

The present study examined the tripartite model of intrinsic motivation though meta-analysis and in doing so summarizes 30 years of research. Results indicate that each type of intrinsic motivation is associated with positive education outcomes such as improved academic achievement and experiences of positive affect and may be associated with minor reductions in negative states such as anxiety and negative affect. Theoretically proposed antecedents were also found to predict intrinsic motivation types as expected with the psychological need for competence being the key predictor of intrinsic motivation types in students. However, whereas IM-stimulation was found to relate to covariates differently, thereby indicating its validity, IM-know and IM-accomplished were predicted through the same pathway and related to outcomes in a highly similar manner. Paired with very high intercorrelations leading to multicollinearity, these results point toward impractical redundancy across the three types of intrinsic motivation.

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Data and Supplementary Materials:

The full dataset and all associated supplementary materials are made available through Open Science Framework at the following link:

https://osf.io/byscn/?view_only=245905ada5244ea6b777a1e6851889e2

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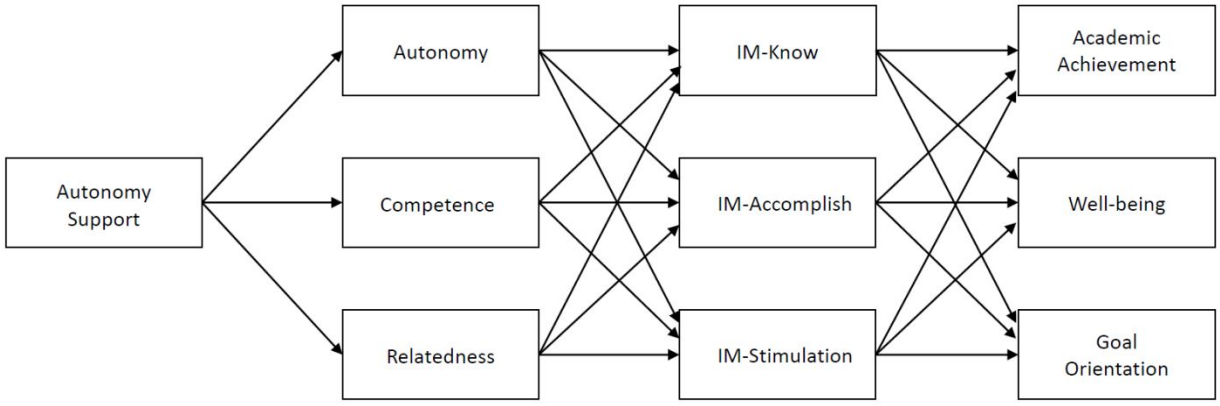
TRIPARTITE MODEL OF INTRINSIC MOTIVATION

Figure 1. *Hypothesized path diagram of study variables.*



TRIPARTITE MODEL OF INTRINSIC MOTIVATION

Table 1. *Correlations between Intrinsic Motivation Subscales*

IM Type	Knowledge	Accomplishment	Stimulation
Knowledge	-	61	62
Accomplishment	.859	-	61
Stimulation	.829	.832	-

Note. Meta-analytic correlations below the diagonal. Number of included samples above the diagonal.

Table 2. *Meta-Analytic Correlations between Types of Intrinsic Motivation and Antecedents*

Covariate				95% CI				
Intrinsic Motivation	*k*	N	ρ	Lower	Higher	SE	T^2	I^2
Autonomy								
Knowledge	9	4602	.45	.34	.56	.05	.01	86.35
Accomplishment	9	4602	.43	.33	.53	.04	.01	83.69
Stimulation	9	4602	.41	.28	.55	.06	.02	91.39
Competence								
Knowledge	11	6223	.48	.39	.56	.04	.01	82.96
Accomplishment	10	4819	.47	.34	.59	.06	.02	89.42
Stimulation	10	4819	.38	.21	.56	.08	.04	95.25
Relatedness								
Knowledge	6	3519	.41	.36	.47	.02	.00	32.27
Accomplishment	6	3519	.38	.29	.48	.04	.01	74.59
Stimulation	6	3519	.44	.37	.51	.03	.00	57.20
Autonomy Support								
Knowledge	7	4153	.31	.18	.43	.05	.01	81.80
Accomplishment	6	3081	.30	.05	.54	.10	.06	96.15
Stimulation	7	3469	.26	.05	.46	.08	.03	93.27

Note. k = number of samples; ρ = correlation after correction for reliability and weighted by samples size.

TRIPARTITE MODEL OF INTRINSIC MOTIVATION

Table 3. *Path Analysis of Antecedents of the Tripartite Model of IM*

Motivation Type		Direct Effects		Indirect Effect from Autonomy Support to IM	
	Antecedent	β	95% CI	β	95% CI
IM - know					
	Autonomy Support	.03	-.01; .06		
	Autonomy	.13*	.08; .18	.08*	.05; .11
	Competence	.28*	.23; .32	.13*	.11; .15
	Relatedness	.14*	.11; .18	.08*	.06; .09
Total Indirect				.28*	.26; .30
Total Effect AS to IM-Know				.31*	.28; .33
IM - Accomplish					
	Autonomy Support	.03	.00; .07		
	Autonomy	.12*	.07; .17	.07*	.05; .10
	Competence	.30*	.26; .34	.14*	.12; .16
	Relatedness	.10*	.06; .14	.05*	.03; .07
Total Indirect				.26*	.24; .29
Total Effect AS to IM-Accomplish				.30*	.27; .32
IM - Stimulation					
	Autonomy Support	-.06*	-.10; -.03		
	Autonomy	.22*	.17; .27	.14*	.11; .17
	Competence	.06*	.01; .10	.03*	.01; .04
	Relatedness	.30*	.26; .33	.16*	.14; .18
Total Indirect				.32*	.30; .34
Total Effect AS to IM- Stimulation				.26*	.23; .28

Note. * denotes $p < .05$.

TRIPARTITE MODEL OF INTRINSIC MOTIVATION

Table 4. *Meta-Analytic Correlations between Types of Intrinsic Motivation and Outcomes*

Covariate				95% CI				
Intrinsic Motivation	*k*	N	ρ	Lower	Higher	SE	T^2	I^2
GPA (Self-Report)								
Knowledge	11	4577	.12	.05	.19	.03	.01	72.65
Accomplishment	10	4393	.16	.10	.22	.03	.00	61.09
Stimulation	11	4577	.03	-.07	.14	.05	.02	85.85
GPA (Objective)								
Knowledge	19	11350	.17	.10	.23	.03	.03	93.56
Accomplishment	16	8040	.13	.05	.20	.04	.02	88.77
Stimulation	16	8040	.06	-.01	.13	.03	.02	88.56
Positive Affect								
Knowledge	8	3206	.37	.26	.48	.05	.01	83.30
Accomplishment	7	3022	.36	.23	.50	.05	.03	91.46
Stimulation	8	3206	.29	.14	.43	.06	.03	90.02
Satisfaction								
Knowledge	9	3384	.36	.23	.49	.06	.03	92.08
Accomplishment	8	3200	.38	.22	.54	.07	.04	94.18
Stimulation	9	3384	.32	.09	.55	.10	.12	97.55
Negative Affect								
Knowledge	8	2783	-.13	-.23	-.03	.04	.01	78.41
Accomplishment	7	2599	-.09	-.18	.00	.04	.01	71.59
Stimulation	8	2783	-.08	-.20	.03	.05	.01	75.97
Anxiety								
Knowledge	7	2413	-.15	-.28	-.02	.05	.01	81.44
Accomplishment	6	2229	-.11	-.29	.07	.07	.02	88.69
Stimulation	7	2413	-.08	-.26	.09	.07	.03	90.47
Engagement								
Knowledge	7	3783	.39	.22	.57	.07	.04	94.63
Accomplishment	7	3783	.41	.21	.61	.08	.04	95.02
Stimulation	7	3783	.32	.15	.48	.07	.04	95.18
Self-Efficacy								
Knowledge	10	4696	.42	.34	.49	.04	.01	80.51
Accomplishment	10	4696	.35	.31	.39	.02	.00	30.11
Stimulation	11	5084	.31	.24	.38	.03	.01	75.64

Note. k = number of samples; ρ = correlation after correction for reliability and weighted by samples size.

Table 5. *Meta-Analytic Correlations between Types of Intrinsic Motivation and Goal Types*

Covariate				95% CI				
Intrinsic Motivation	*k*	N	ρ	Lower	Higher	SE	T^2	I^2
Mastery-Approach								
Knowledge	5	2698	.17	.11	.23	.02	.00	0.00
Accomplishment	5	2698	.29	.22	.36	.02	.00	16.02
Stimulation	5	2698	.19	.13	.25	.02	.00	0.00
Mastery-Avoidance								
Knowledge	3	2253	.05	-.17	.27	.05	.01	83.46
Accomplishment	3	2253	.09	-.21	.38	.07	.01	91.07
Stimulation	3	2253	.08	-.13	.30	.05	.01	82.07
Performance-Approach								
Knowledge	5	2698	.54	.50	.59	.01	.00	0.00
Accomplishment	5	2698	.52	.43	.61	.03	.00	51.32
Stimulation	5	2698	.41	.33	.50	.03	.00	51.92
Mastery-Avoidance								
Knowledge	5	2698	-.08	-.29	.14	.08	.02	90.67
Accomplishment	5	2698	.01	-.24	.25	.09	.03	93.35
Stimulation	5	2698	-.02	-.29	.24	.09	.03	94.24

Note. k = number of samples; ρ = correlation after correction for reliability and weighted by samples size.

Table 6. *Relative Weight and Path Analysis of Tripartite Model of IM Predicting Outcomes*

Outcome	R^2	IM-Know		IM-Accomplish		IM-Stimulation	
		β	RW (%)	β	RW (%)	β	RW (%)
GPA (Self-report)	.06	.10	25.29	.37	48.96	-.36	25.75
GPA (Objective)	.05	.35	55.12	.05	24.80	-.27	20.08
Positive Affect	.15	.29	42.59	.23	38.14	-.14	19.27
Satisfaction	.15	.15	34.28	.29	42.58	-.04	23.14
Engagement	.18	.21	36.28	.35	44.20	-.15	19.52
Negative Affect	.02	-.23	62.47	.05	20.78	.07	16.75
Anxiety	.03	-.27	61.01	.02	22.84	.12	16.15
Self-Efficacy	.18	.48	52.08	.04	28.11	-.12	19.81
Mastery-Approach	.11	-.27	18.51	.58	62.75	-.07	18.74
Mastery-Avoidance	.01	-.13	18.90	.15	48.85	.07	32.26
Performance-Approach	.32	.46	43.84	.33	37.75	-.25	18.41
Performance-Avoidance	.03	-.36	52.76	.28	31.01	.04	16.23
Average			41.93		37.57		20.51

Note. Regression weight derived from path model are highly influenced by multicollinearity and therefore not trustworthy.