Predicting Intrinsic Motivation

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Abstract

Intrinsic motivation can be predicted from participants' perceptions of the social environment and the task environment (Ryan & Deci, 2000)in terms of control, relatedness and competence. To determine the degree of independence of these factors 251 students in higher vocational education (physiotherapy and hotel management) indicated the extent to which they perceived control, relatedness, and competence in different types of education, their motivation to learn, and their study behaviors. Principal component analysis showed that the perceptions of control, relatedness and competence are so strongly related that when students rate one of the constructs negatively, such as their perception of the task control, they will also rate the others (relatedness and perception of competence) more negatively. These results were confirmed by analyses of two additional data sets. Consequences for measurement issues and motivational science are discussed.

Predicting Intrinsic Motivation

In the past two decades there has been a strongly renewed interest in the study of motivation in relation to learning. Simon (1995), for example, noted that it "is imperative for progress in instructional methods that we deal simultaneously with cognition and motivation in our research… We already have too much medicine that is (cognitively) good for the patient – who will not take it - and medicine that patients find delicious – but that contributes little to their cognitive abilities"(p. 508). Pintrich (2003) described this as a *motivation science* coming into being.

This interest has much to do with a new view on education. Simons, van der Linden, and Duffy (2000) for example stress *new* instructional methods (in their words "new learning") such as independent learning, discovery learning, experiential learning, self-directed learning, problem-oriented education, simulations, and work-based learning. To a large extent, these methods are based on constructivism in which, according to Reiser (2001), learners are responsible for their own learning process. Such self-regulated learners are motivated, independent, and metacognitively active participants in their own learning (e.g., Bastiaens & Martens, 2000; Dalgarno, 1998; Duffy, Herrington & Oliver, 2000; Lowyck & Jonassen, 1993; Pierce & Jones, 1998; Wolters, 1998). All of these instructional methods hold that stimulating motivation is crucial in learning, but while an increasing number of researchers are trying to link instructional strategies, motivational processes and learning outcomes (Ellinger, 2004; Garris, Ahlers & Driskell, 2002), the research evidence is still "embryonic" (Garris et al., p. 442).

Motivation is not an easy concept to define because it is related to many partly overlapping theoretical constructs (Norwich, 1999). On the one hand it is be seen as a relatively stable personality trait (e.g., Sheldon, Ryan, & Reis, 1996), while on the other hand it is seen to vary from situation to situation (e.g., Boekaerts & Minnaert, 2003). This article sees motivation as the latter case and finds its roots in the work of Ryan and Deci (2000) who distinguish between extrinsic motivation, which refers to the performance of an activity in order to attain a certain outcome, and intrinsic motivation, which refers to doing an activity for the inherent satisfaction of the activity itself. The effort or motivation on which constructivist learning environments try to rely is typically intrinsic motivation, with its associated features as curiosity, deep level learning, explorative behavior and self regulation (Martens, Gulikers, & Bastiaens, in press). Research has shown that intrinsically motivated students exhibit study behaviors that can be described as explorative, reflective, self-regulated, and aimed at deep level processing (e.g., Boekaerts & Minnaert, 2003; Martens et al, in press; Ryan & Deci, 2000).

Ryan and Deci developed a model to explain and predict the persistence of intrinsic motivation. They state : "…our theory of motivation does not concern what causes intrinsic motivation (which we see as an

evolved propensity; Ryan et al, 1997); rather it examines what conditions sustain versus subdue and diminish, this innate propensity" (p. 70). This approach can be linked to evolutionary psychology and can be found, for example, in work by Bjorklund and Bering (2002) and Bjorklund and Pellegrini (2002). In their view, if humans become *amotivated* there is a reason for this in their perceived social and physical environment. This is quite different from the often taken developers' viewpoint that it is the developer (of education, of games, of …) who has to make the material motivating (e.g., the ARCS Model of Motivation from Keller and Suzuki, 1988). In spite of this theoretical difference, practical advice and guidelines derived from both viewpoints partly overlap.

Cognitive Evaluation Theory (Ryan and Deci, 2000) predicts that the perception of certain aspects of the social and task environment are crucial to intrinsic motivation. These perceptions may influence each other, but exactly how is unclear. More specifically, a sense of relatedness, control or competence is seen to be positively correlated with intrinsic motivation. Various authors describe these aspects as predictors, factors or mediators. If, for instance, the amount of control is varied, then the perception of control can be considered as a mediator between variation in control and intrinsic motivation. For purposes of clarification, this article will speak of the perception of relatedness, control and competence as predictors since they can be seen to predict intrinsic motivation.

Cognitive Evaluation Theory describes stages in motivation, varying from amotivation via introjection to intrinsic motivation for which scales have been developed. Although the debate is still going on, quite some research evidence for this model has been built. Some of this evidence will be presented here.

Perception of control has been shown to be positively correlated with intrinsic motivation (Enzle & Anderson, 1993; Hardre & Reeve, 2003; Nichols, 2004; Pelletier, Seguin-Levesque, & Legault, 2002). Raffini (1996) stated that students' need for a sense of autonomy or self-determination significantly influences their intrinsic motivation to learn in the classroom and stresses the importance of building a sense of autonomy in students by providing them with choices. This effect has also been reported for educational software, for example, by Cordova and Lepper (1996) and Kinzie, Sullivan and Berdel (1988). Iyengar and Lepper (2000) also found that too much choice or control can be experienced. Deci, Koestner and Ryan (1999) performed a meta-analysis on the effects of extrinsic rewards - a form of external control (Henderlong & Lepper, 2002; Norwich, 1999) - on intrinsic motivation and found that many forms of external reward undermine intrinsic motivation.

Perceived competence is the whole complex of beliefs about one's own competences and as such is highly related to self-esteem, the evaluation of one's self-concept. According to Harter (1990), perceived competence is an important psychological mediator of achievement behavior and motivation among children and adolescents in the academic domain and has often been demonstrated to affect intrinsic motivation. In a correlational study, children's self-reported perceptions of academic competence and personal control were found to be positively related to their intrinsic interest in schoolwork and preference for challenging school activities (Boggiano, Main, & Katz, 1988). Competence can be perceived through praise, through comparisons with other students or other indications of good performance or through meaningful effort (e.g., Henderlong & Lepper, 2002). Finally, objective mastery praise has been shown to be better than social comparisons in affecting motivation (Henderlong, Tomlinson, & Stanton, 2004).

Finally, a *sense of relatedness* (belongingness or connectedness with others) has quite often been demonstrated (e.g., Ryan & Deci, 2000; see also Furrer & Skinner, 2003 for an overview) to have a positive impact on intrinsic motivation, and thus on engagement and persistence. Relatedness is characterized by fulfillment and involvement with the social world. This social aspect affects relatedness by creating a climate or culture of trust, respect, caring, concern, and a sense of community with others. In a related area Kreijns and Kirschner (2004) have studied the role of this social interaction in collaborative learning. They show that the existence of a sound social space - the network of social relationships amongst the group members embedded in group structures of norms and values, rules and roles, beliefs and ideals - is essential for reinforcing social interaction. A social space is ´sound´ if it is characterized by affective work relationships, strong group cohesiveness, trust, respect and belonging, satisfaction, and a strong sense of community (cf. Rourke, 2000; Rovai, 2001).

What then are the effects of intrinsic motivation on learning? Cordova and Lepper (1996) tried to increase children's intrinsic motivation in educational software. As predicted, children exposed to motivationally embellished activities displayed higher levels of intrinsic motivation. As a result, they became more deeply involved in their activities, used more complex operations, and learned more from the activities in a fixed period of time. Another effect found is that the risk of drop-out decreases (Hardre & Reeve, 2003; Vallerand, et al., 1997). Intrinsically motivated students are more persistent and more likely to achieve set goals (Curry, Wagner & Grothaus, 1990), and have higher levels of self-regulation (Pintrich & de Groot, 1990) than

those who are not intrinsically motivated. Intrinsically motivated adult students tend to exhibit higher subjective well-being (Levesque, Zuehlke, Stanek, & Ryan, 2004). Low intrinsic motivation, on the other hand, has been shown to be correlated with educational self-handicapping, avoidance behavior, loss of social support networks, and passivity (Thompson, 2004). Overviews (e.g., Ryan & Deci) indicate that intrinsically motivated students are more curious and engage in more deep level learning, an effect that holds true for students of all age groups (cf. Bruinsma, 2003; Turner et al, 1998; Wolters & Pintrich, 1998;). It is, however, not necessarily the case that more extrinsically motivated students always do less (Ryan & Deci, 2000). Martens et al (in press) found that students with high intrinsic motivation do not do more in computer based learning programs, but do different things (i.e., they exhibit more exploration behavior). A compounding problem is that it sometimes is impossible to design educational tasks that are intrinsically motivating to all students (Kaufmann & Husman, 2004). In other words, we need to know more about how motivation affects cognition. This is, according to Pintrich (2003), one of the leading questions to be answered by the 'motivational science'. Thus, although it is clear that perception of control, relatedness and competence are related to intrinsic motivation, it is unclear how they are interrelated. Rarely do researchers present data about such mediators or predictors and even more rarely are these data presented with all the possible mediators together. That there are relations is evident, since all these predictors are related to scales measuring intrinsic motivation.

For any science the exact measurement of its basic constructs is crucial. Unfortunately, in motivational research there are four important problems that hinder this, namely.

- It is unclear how control, relatedness and competence are related. Do they strengthen each other? Do they compensate for each other?
- Most researchers do not measure these three predictors. Reeve, Nix and Hamm (2003), based upon an analysis of more than 300 studies, conclude that very few researchers actually investigate the impact of what may be called autonomy (or lack of control or choice) as a possible mediator in the relation between choice and intrinsic motivation.
- There are serious measurement and definition problems such as what the exact definition is of perceived control. Deci and Ryan (1987), for example, see autonomy or the absence of external control as a theoretical concept connoting an inner endorsement of one's own actions (origin, personal causation, internal locus), an experience during that action of high flexibility and low pressure (psychological freedom), and a sense that one's actions are truly chosen (perceived choice). Current theoretical statements treat these qualities as overlapping and mutually supportive, but others doubt this (e.g., Reeve et al., 2003).
- Investigators who routinely use different psychometric measures to operationally define the three predictors often rely either on a single item predictor (Boggiano et al., 1993; Eisenberger, Rhoades, & Cameron, 1999; Overskeid & Svartdal, 1996) or only a pair of items (Reeve & Deci, 1996; Thompson, Chaiken, & Hazelwood , 1993). According to Reeve et al. (2003) "researchers question the validity, internal consistency, and conceptual ambiguity these measures generate. This limits researchers' attempts to theoretically understand and operationally define self-determination as an ephemeral, situationally sensitive, and statelike experience (i.e., state self-determination). In contrast, efforts to assess perceived self-determination as an enduring characteristic in the personality (i.e., trait self-determination) have been deemed psychometrically sound." (p. 375). Highly reliable, valid, and educationally useful instruments to assess trait self-determination include the Academic Self-Regulation Questionnaire (Ryan & Connell, 1989), the Causality Orientations Scale (Deci & Ryan, 1985), and the Academic Motivation Scale (Vallerand et al., 1992). Unfortunately as soon as we try to more measure perceived self-determination as based on the context or situation, it is a less stable measure. However, this is exactly what happens in most cases. Based on adaptations from scales used, most researchers develop their own variations that are specific for a certain context. These adapted scales are quite often used in correlational research and covariance structure analysis alternatively known as Structural Equation Modeling (SEM).

This brings us to the main research question of this article, namely: If multiple reliable scales to measure the perception of control, relatedness and competence in different educational situations are constructed, how many factors then underlie these predictors? An explorative analysis investigated the number of factors that underlie the predictors focusing not on questionnaire construction, but on the connection between the predictors that the scales measure. In addition, the study behavior that coincides with high intrinsic motivation is also studied. Bruinsma (2003), Ryan and Deci (2001), Turner et al. (1998) and Wolters and Pintrich (1998) all found that intrinsically motivated students generally learn at a deeper level, are more self-regulated and are more communicative than those who are not. These effects appear to occur together, possibly meaning that the

predictors are linked. If, for instance, high motivation coincides with study behavior in which the learner is more communicative, then it is likely that the predictors are strongly related since it is quite conceivable that communication is related to a perception of relatedness.

Method

Participants

Participants were 251 full-time undergraduate students, studying Physiotherapy or Hotel Management at a Dutch polytechnic. They were in the second, third or final year of the four year program and had an average age of 20.8 years (*SD* = 2.04). Seventy five percent of the participants was female. Participation (the filling in questionnaires) was voluntary and anonymous with a response rate of 80%.

Procedure

Five distinct educational systems were distinguished in five specific courses given at the polytechnic, namely:

- *Skills-based*, where physiotherapy students were involved in skills training;
- *Problem based learning* (PBL), where physiotherapy students received education based upon specific physiotherapy problem cases in tutor groups;
- *4C/ID*, where students received education according to a competency based educational approach set up following the Four-Component Instructional Design (Van Merriënboer, 1997);
- *Practice-based*, where physiotherapy students were involved in their internship period at the end of their education; and
- *Virtual Hotel School* (VHS), where students from the Hotel Management School work together in a virtual company.

Instruments

Four scales were developed / adapted to measure perceived control, perceived competence, perceived relatedness and intrinsic motivation. Each scale contained between three and seven items (7-point Likert scales). In Table 1 the scales are summarized with respect to their size and reliabilities. Though generic in nature, the scales were minimally specified to suit the specific educational setting in which they were administered (i.e., substitution of the word problem in PBL for task in 4C/ID). Most items were common over all educational types. Table 1 also contains examples of the items (translated from Dutch).

Table1. *Scale Reliability*

Scale and example of item	Cronbach's Alpha, (number of items) and number of respondents				
	Skills	PBL	4C/ID	Practice	VHS
Perceived control	.65 (3)	.60 (4)	.65 (5)	.57 (3)	.56 (3)
'This activity was mandatory'	n=65	n=64	n=50	n=27	n=36
Perceived competence	.75 (3)	.66 (3)	.85 (5)	.87 (5)	.64 (4)
'I think I'm good at this activity'	n=65	n=68	n=53	n=27	n=34
Perceived relatedness	.64 (6)	.55 (3)	.60 (5)	.82 (6)	.71 (4)
'I trust my peer students'	n=62	n=69	n=51	n=24	n=34
Intrinsic motivation	.84 (6)	.87 (6)	.75 (7)	.91 (4)	.96 (6)
'I like this activity'	n=60	n=65	n=51	n=26	n=34

Single items (7-point Likert scales)were used for the measurement of study behavior, and thus no reliability scores were calculated. These items measured *effort* invested by the participant, learning aimed at trying to *understand* the content, trying to *use* learning content in practice, having *discussed* the content with other students, *concentration*, ease of *recall*, *curiosity* about content, and feeling of being easily *distracted*.

Results

The Scales

First, the bivariate correlations between each of the different predictors and with intrinsic motivation were determined (see Table 2). Since the constructs are significantly correlated and meet with all parametric

criteria necessary to calculate such correlations, a principal component analysis (PCA) on the scales was then performed, in an attempt to explain as much variance as possible.

Table 2. *Bivariate Correlations of Predictors and Intrinsic Motivation*

	Perceived control	Perceived competence	Perceived relatedness	Intrinsic motivation
Perceived control	1	.028	.163*	.174*
Perceived competence		1	.355**	.411**
Perceived relatedness			1	.508**
Intrinsic motivation				1

*= p<.01; **=p<.0001; two-tailed, n=250

Principal component analysis on this correlation matrix revealed a 1-component solution with the following loadings: perceived control = .323; perceived competence = .696; perceived relatedness = .796, and intrinsic motivation = .827.

Table 3. *Total Variance Explained after Principal Component Analysis*

	Initial Eigenvalue			Extraction SSL		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.907	47.676	47.676	1.907	47.676	47.676
2	.980	24.509	72.185			
3	.632	15.798	87.983			
4	.481	12.017	100.000			

The principal components analysis shows a 1-component solution with the criterion eigenvalue > 1, although (with a two component solution) the second component on which perceived control loads does, explain a substantial part of the variance. Inspection of the reliability estimates in Table 1 indicates that a source of error variance might be the unreliability of the perceived control scales. In other words, due to a certain amount of unreliability of the measurement of one of the four variables, the correlations between these variables may be underestimated. This can be rectified by making use of a correction of attenuation (e.g., Schmidt & Hunter, 1996). By dividing the bivariate correlation by the root of the weighted reliability coefficients the estimated correlation coefficients - if both variables were measured with perfect reliability - are achieved. These correlations are shown in Table 4.

Table 4 *Correlations after Correction for Attenuation*

	Perceived control	Perceived competence	Perceived relatedness	Motivation
Perceived control	1			
Perceived competence	.04	1		
Perceived relatedness	.26	.49	1	
Motivation	.24	.51	.69	1

Principal component analysis based on this correlation matrix again yields a 1-component solution with the loadings: perceived control = .384; perceived competence = .732; perceived relatedness = .874, and intrinsic motivation = .878.
The correction for measurement unreliability shows an increase in the explained variance (Table 5).

Table 5 *Total Variance Explained with Principal Component Analysis after Correction for Attenuation*

	Initial Eigenvalue			Extraction SSL		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.218	55.442	55.442	2.218	55.442	55.442
2	.968	24.212	79.655			
3	.505	12.614	92.268			
4	.309	7.732	100.000			

To determine whether these results are unique, or whether there may be other corroborating evidence, two secondary studies were carried out. First this approach was repeated on data of an already published study (Ntoumanis, 2003). Second, new research with a different population in the Netherlands using the same instruments was carried out. These results will be reported in a forthcoming article.

Analyzing the Ntoumanis (2003) data yields the same picture as the first analysis presented. Ntoumanis uses scales to predict intrinsic motivation with moderate to high reliability (ranging from .43 for autonomy to .87 for intrinsic motivation). The correlations, standard deviation and number of participants presented by Ntoumanis were entered in a matrix as input for PCA. Before correction for attenuation a 2-component solution was found; after correction a 1-component solution was found.

Original data from a second, new research sample was also analyzed. This sample consisted of 338 higher education students studying in the Netherlands in full-time higher vocational education at the Maastricht School for Hotel Management. A small majority of the students was female (60%) and had an average age of 19.1 years. The students filled in the same questionnaires as in the original study. All scales had moderate to high reliability. The exact coefficients can be found in Appendix 2. Again PCA resulted in a 1-factor solution, with the criterion of Eigenvalue > 1.

These analyses all point in the same direction, namely that if the unreliability of measurement common for scales used to predict motivational processes, scales for autonomy, relatedness, competence and intrinsic motivation are taken into account, they appear to measure the same construct.

Study Behavior

As stated earlier, a second aim of this research was to determine the impact of intrinsic motivation on self-rated study behavior. Table 6 shows that intrinsic motivation appears to coincide with specific study behaviors.

Table 6. *Correlations between Intrinsic Motivation and Self Reported Study Behavior*

	Effort invested	Learn for under-standing	Use content in practice	Discuss content with others	Good concen-tration	Easy to remember	Curious about content	Feel easily distracted
intrinsic motivation	.526	.445	.434	.233	.478	.440	.638	-.240
N	250	250	223	248	248	249	247	245

All correlations are significant at the .001 level (2-tailed)

Students with high intrinsic motivation exhibit a higher degree of effort, perceive the learning materials as being more useful, are inclined to learn more for understanding, try to apply what they learn in their practice, and appear to discuss the content more with other students. They report having better concentration, more curiosity and say that they find it easier to remember the learning content. Finally, they report feeling less distracted while studying. Again this combination of study behaviors accompanying intrinsic motivation shows, as predicted, how strongly related the perceptions are. If, for example, high intrinsic motivation is correlated with more inclination to discuss and communicate what has been learned with fellow students, this will probably be linked to a more positive perception of relatedness.

Discussion

It is widely accepted (see Ryan and Deci, 2000 for an overview) that perception of relatedness, control (or autonomy), and competence predicts intrinsic motivation, which in turn predicts study behavior. Less clear is how these three predictors are related. This research shows that they are so strongly correlated that in fact they appear to be constituents of the same process. Functionally, they form one single factor. This means that a negative perception of one of the three predictors always comes jointly with a negative perception of the other

two. In plain English: if you feel amotivated because someone is constantly commenting on what you do and telling you exactly what to do (thus decreasing your perception of autonomy), it is very likely that you will not only experience a low perception of relatedness to this person (i.e, alienation), but that you also will not feel very competent at the task at hand. Or: if you have to partake in a sport activity that you do not feel that you are very good at (i.e., a low perception of competence), you will probably both dislike the activity (experience a loss of intrinsic motivation), but will also experience a loss of relatedness or belongingness with your teammates. In other words, manipulations intended to influence any one of the three aspects - perceived relatedness, competence and autonomy - will also influence the other two.

This study also shows that when scales to measure the predictors of intrinsic motivation are well constructed (i.e., high reliability) one can rely on measuring only one predictor, since the other predictors all seem to be part of the same mechanism (i.e., construct). This 'mechanism' also explains the typical reactions that are commonly found (e.g., Wolters & Pintrich, 1998) to be related with low intrinsic motivation. These effects were replicated in this study: students with low intrinsic motivation tend to be less inclined to interact with their peers or to discuss the study content, phenomena that can be linked to lower feeling of relatedness. This lower relatedness can be interpreted as an avoidance tendency: if forced to join a certain a group and engage in certain unpleasant activities people will tend to want to leave this group.

Some critical remarks also have to be made. First, principal component analysis is a technique where the result depends on many elements. The same holds true for related techniques such as exploratory or confirmatory factor analysis. In general, discussions on the number of factors that underlie psychological measurements are difficult and lengthy. It took a long time to reach agreement about the 'big five' factors used to map personality (e.g., Schmit & Ryan, 1993) as well as on the factors underlying verbal intelligence. It is, thus, quite likely that other research, both exploratory and confirmatory, with other data might lead to different factor solutions, even though this article reported three samples that all pointed in the same direction. Also, the correction for attenuation used, only yields a hypothetical estimate of the correlation that would appear after a perfect measurement.

Nevertheless the results presented in this study provide evidence for the idea that there appears to be a connected functional mechanism underlying motivational processes. This is in line with other findings suggesting (e.g., Ryan & Deci, 2000; Thompson, 2004) that suggest that diminished intrinsic motivation comes along with a specific but broad set of related consequences, varying from passivity, to lower well-being, less communication, avoidance behavior, and so on. This mechanism can be tentatively termed an 'amotivation module'.

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