Development of a Physics Goal Orientation Survey

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Abstract

A key question in learning and teaching is: What motivates students to learn? In the second half of the 20th century achievement goal theory emerged as a key feature of the motivation literature. This theory focuses on what motivates students toward actions that will result in learning; students have particular goals and beliefs that orient them to select particular strategies and ways of learning and planning their success.

Although motivation and goal orientations influence student learning outcomes, there appear to be no studies on goal orientations in university physics. This study focused on developing a goal orientation survey specific to university physics studies. A pilot study was undertaken in 2006 (Lindstrøm & Sharma, 2008). This paper describes the continuation and conclusion of the study in 2007 and 2008 spanning five administrations, each with sample sizes between 162 and 360 students.

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Introduction

Motivation is an area concerned with understanding the reasons for and the consequences of what brings us to learn in the first place. It is the stepping stone to learning and thus an essential part of the learning process. Several theories of motivation exist, but achievement goal theory is perhaps the most prominent (Urdan, Kneisel & Mason, 1999).

Achievement goal theory focuses on students' *reasons* for engaging in academic tasks, because these affect important educational outcomes such as types of cognitive strategies used and how well newly learnt material is retained (Anderman, Austin & Johnson, 2002). The goals described are task specific, rather than individual specific, and can change with time due to individual reasons or environmental influences.

Two different types of goal orientations, known by different names in different circles, form the core of achievement goal theory. The mastery (Ames, 1992), learning (Dweck & Leggett, 1988) or task (Duda & Nicholls, 1992) orientation refers to the aim to increase competence with respect to self-set standards, focusing on mastery, learning and understanding (Linnenbrink & Pintrich, 2001). Mastery-oriented students are intrinsically motivated, value progress and enjoy taking on challenges, and view mistakes as part of the learning process (Anderman et al., 2002). The performance (Ames, 1992), self-enhancing (Skaalvik, 1997) or ego (Duda & Nicholls, 1992) orientation is, unlike the mastery orientation, extrinsically motivated. The focus is on the outcome of a task, competence is normatively measured (i.e., with respect to others) and a key feature of the performance goal is the establishment of one's position in the hierarchy of relative competence.

In recent times, additional goal orientations have been proposed. Work avoidance is one in which the student attempts to maximise performance by minimising effort (Nicholls, Cobb, Wood, Yackel &

Petashnick, 1990). Another addition has been prosocial goals (Covington, 2000), which focus on the social aspect and environment of the learning situation; cooperation is one such prosocial goal orientation.

Purpose of this study

When the complexity of the different goal orientations and their interrelationships began to receive attention in the 1990s, it opened up a new area of research (Covington, 2000). Much of this research is concerned with the similarities and differences between the various goal orientations. A good example is Duda and Nicholls' (1992) study of the dynamic interaction between goal orientations in the contexts of classroom and sport respectively – including both work avoidance and cooperation in addition to task and ego orientations.

A review of the achievement goal theory literature since the 1990s reveals several issues. First, most studies in achievement goal theory are carried out in schools, very few in universities. Second, studies can be domain and context specific, or general. In other areas of motivation, studies in which instrument and measure have the same level of specificity have produced the highest level of correlation (Choi, 2005; Lent, Brown & Gore, 1997). For example, physics students may be competent at solving mechanics problems involving inclined planes (very specific), but still lack confidence in their ability to do well in a physics course (general). Third, no achievement goal theory instrument developed for the tertiary physics context was found. We therefore decided to develop a discipline specific goal orientation survey for tertiary physics. In this paper we report on this development and the preliminary findings from the survey and associated focus group data. The study has approval from the Sydney University Human Research Ethics Committee.

Developing a goal orientation survey for physics

Item selection

Surveys that measure aspects of motivation were carefully perused (such as Duda & Nicholls 1992; Meece, Anderman & Anderman, 2006; Shimoda, White & Frederiksen, 2002; Skaalvik, 1997) to identify adequate items for the ego, task, work avoidance and cooperation orientations. Duda and Nicholls (1992) emerged as the most pertinent work for three reasons: they had already developed and implemented a survey with eleventh grade students with sound statistical results; their survey had all four goal orientations we were interested in; and Duda and Nicholls' (1992) survey had been adapted to and trialled in such different contexts as classroom and sport. Therefore, we decided to adapt items from Duda and Nicholls' (1992) survey to our tertiary physics context.

To be reliable, every orientation should ideally have at least four items that each probe slightly different aspects of the construct and satisfy certain statistical criteria (Field, 2000). We therefore decided to have five items per orientation.

Item development

Duda and Nicholls' (1992) survey items were adapted to a first year university physics context. Specific references that were changed included class size (which are much larger at university) and students' knowledge of other students' performances (e.g., our students do not know their class rank order); the word 'friends' was substituted with 'other students', and 'things' with 'physics'; and references to assessments were changed in light of the university structure (e.g., to 'goof off' has a different meaning at university where attendances are not compulsory and 60% to 65% of the assessment is based on a final examination). Two examples of how statements were altered – one simple, one drastic – are provided here: *"Others get things wrong and I don't"* was changed to *"Others get physics problems wrong and I don't"*, and *"I can goof off"* was completely rewritten to

"I get marks because my lab partners do most of the work", while still keeping the sentiment. It was important that each orientation had items covering different relevant aspects of the physics course, e.g., the work avoidance orientation needed to include situations where work was required: studying for the examination, doing assignments, working in tutorials, and answering questions in class.

For the ego and task orientations, eight items each were available from Duda and Nicholls' survey; five items that transferred to the university physics situation were chosen for each orientation. The following is an example of how the selection was made: in the three statements *I feel successful when… "I beat others"*, *"I can do better than my friends"*, and *"Others can't do as well as me"*, the sentiment was the same, so the item *"I do better than others in physics"* was used. Duda and Nicholls' (1992) survey only had three items available for work avoidance and two for cooperation. Two of the work avoidance items were used and three new were created. For the cooperation orientation both items were used and three new items were written; the five items targeted both group work and discussing physics with fellow students.

Validation by experts

Our survey was given to three experts experienced in physics education research and physics teaching to scrutinise its validity. The experts were asked to comment on the following: whether the items were appropriately adapted to tertiary physics, whether the items satisfied the definition of the relevant goal orientations, whether the items adequately encapsulated the relevant aspects of the orientation to which they belonged, and the general wording of each item. The experts only suggested minor changes to the survey, which were incorporated, resulting in the first version of the Physics Goal Orientation survey.

Table 1. Flowchart of versions and administrations of the survey.

Version 1
- Administration 1: Week 4 of first semester of 2006 in lectures with 125 responses.
- Administration 2: Week 3 of first semester of 2007 in lectures with 352 responses.
- Administration 3: Week 13 of first semester of 2007 in tutorials with 331 responses.

↓

Version 2
- Administration 1: Week 13 of first semester of 2008 in tutorials with 360 responses.
- Administration 2: Week 4 of second semester of 2008 in tutorials with 256 responses.

↓

Version 3
- Administration 1: Week 13 of second semester of 2008 in tutorials with 162 responses.

Administering the survey

The Physics Goal Orientation survey was trialled six times over three years with first year physics students at the University of Sydney. This allowed us to check for stability (consistency across different times of administration) and invariance (consistency across different samples). Table 1 shows the time, year, venue and sample size for each administration. Different students were sampled each year, but within each year the same students may or may not have completed the different surveys depending on whether they were enrolled in both semesters and whether they chose to return each survey. In all cases, the first author explained the purpose of the survey from a script, emphasising that completion was voluntary and that responses would not affect marks. Only the first author, who was not involved in course evaluation, was allowed access to the original surveys and data file.

Analysis

Lindstrøm and Sharma (2008) explain details of the analysis and decision making throughout the development of the survey. In the following discussion of each version, only those administrations that provided interesting features, added value or were different to Lindstrøm and Sharma (2008) are presented.

Exploratory factor analysis was performed on each administration using SPSS 15.0. A 'factor' is a collection of items that are grouped together in the factor analysis – it is the technical term for a goal orientation. Factor analysis and the measures reported here are standard for surveys of the type used in our study. (Further details about factor analysis can be obtained from Field (2000) and Pallant (2001). See Streiner (1994) or Floyd and Widaman (1995) for a more complex discussion.)

Data were initially checked for suitability for the analysis. This included checking that there were no correlations of $r > 0.8$ in the correlation matrix; the determinants of the correlation matrices were always greater than 0.00001; both overall and individual KMO values were greater than 0.5; and Bartlett's test of sphericity always had $p < 0.05$. All analyses were satisfactory according to these tests. Kaiser's criterion (eigenvalue greater than 1) was used to extract factors; the Scree plot was investigated to check that Kaiser's criterion coincided with retaining the factors that occurred before the inflexion point. A Direct Oblimin (oblique) rotation was then applied. The criteria used for retention of an item in the survey was that it loaded greater than or equal to 0.40 on the intended factor only. There is no clear consensus on the exact requirements of sample sizes (Floyd & Widaman, 1995). Generally a 5:1 ratio between participants and items is accepted, provided the sample is over 100 (Streiner, 1994). Field (2000) claims that where each factor has at least four items with loadings greater than or equal to 0.60, the solution is stable regardless of sample size. Our study meets both these constraints.

Table 2 shows all items used throughout the development of the survey; item references are based on this table. Each item was accompanied by a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5).

Version 1

Version 1 was administered three times. Analyses of all three were internally consistent and showed a surprisingly large deviation from the expected factor structure. The second administration sampled both physics majors and non-majors. The data were analysed separately, confirming that the factor structure was invariant across the two samples. The following paragraphs discuss the three main differences between the observed and expected factor structures and how these were logically and conceptually explained.

The task orientation split into two factors, each with two items. The first pair (items 2.2 and 2.9) referred to the effort invested by students in attempting to master physics. These items were conceptually similar to the original definition, and were therefore retained. The second pair (items 2.7 and 2.8) focused on interest. This is a separate motivational construct, beyond the scope of this study, so the items were deleted.

A similar splitting occurred with the work avoidance orientation. Items 4.1, 4.2 and 4.4 correspond to the original intent where a student can achieve a higher mark than deserved by relying on others. Items 4.5 and 4.6, however, were interpreted by students to mean that they can do well with little effort because they take easily to physics. Thus, the last two items were deleted because they did not conceptually align with Duda and Nicholl's (1992) intended work avoidance orientation.

The last item to be discussed is item 1.6 – "*I get a high exam mark*". This was expected to load on the ego orientation, but loaded both on the ego and the task orientations. Our explanation for this is that a good physics mark at the tertiary level generally not only reflects better performance than others (ego orientation), but also a sound understanding of the subject (task orientation) (we have no multiple choice assessments). Because of this double loading, the item was rejected.

Table 2. Overview of all items used in the development of the Physics Goal Orientation survey. The first letter in square brackets indicates a *N*ew item generated by the authors or *O*ld item adapted from literature. The middle number indicates the version in which the item was first included and the last number the last version in which the item appeared. A dash indicates that the item has been retained for the final version of the survey; only these items have an associated factor loading, which are the factor loadings from version 3. Note that 'Coop' = Cooperation and 'WA' = Work avoidance.

I feel really successful when…

Item no.	Item	Factor loading *Ego*	*Task*	*Coop*	*WA*
1.1	I can answer more physics questions than other students [O,1,-]	0.849			
1.2	I do better than others in physics [O,1,-]	0.809			
1.3	others get physics problems wrong and I don't [O,1,-]	0.798			
1.4	I get things in physics before others do [N,2,-]	0.760			
1.5	I know more physics than other people [O,1,-]	0.592			
1.6	I get a high exam mark [O,1,1]				
2.1	I understand a new physics concept by trying hard [N,2,-]		0.768		
2.2	I solve a problem by working hard [O,1,-]		0.689		
2.3	My efforts to see how different concepts hang together, improve my understanding [N,3,-]		0.674		
2.4	My efforts help me better understand physics [N,3,-]		0.646		
2.5	I understand the course better when I'm studying hard for assignments and the exam [N,3,-]		0.492		
2.6	what I learn in physics makes sense [O,1,1]				
2.7	I learn something interesting [O,1,1]				
2.8	something I learn makes me want to find out more [O,1,1]				
2.9	I do my very best [O,1,3]				
2.10	I understand what is happening in class [N,2,2]				
2.11	I can solve problems that I couldn't do before [N,2,2]				
3.1	I am in a group and we help each other figure something in physics out [O,1,-]			0.832	
3.2	I work in a group on physics problems [N,1,-]			0.798	
3.3	a group of us help each other [O,1,-]			0.794	
3.4	I am in a physics study group [N,2,-]			0.751	
3.5	I have somebody else to discuss physics problems with [N,1,-]			0.590	
3.6	the other students in my tutorial group and I manage to solve a tutorial problem together [N,1,1]				
4.1	others know more than me so they can answer the questions [N,1,-]				0.769
4.2	I can copy an assignment off somebody else [N,1,-]				0.725
4.3	I get marks because my lab partners do most of the work [N,2,-]				0.596
4.4	I can complete an assignment without really having understood the answers [N,1,-]				0.478
4.5	I don't have to try hard to do well in physics [O,1,1]				
4.6	I know I can pass the exam without studying too hard [O,1,1]				
4.7	I can pass the course with minimum understanding of physics [N,2,3]				
	Reliability coefficient - Cronbach alpha	**0.83**	**0.71**	**0.71**	**0.64**

Seven items were deleted from the first version, and seven items were designed to ensure that all orientations had five items each in version 2. The new items were designed to capture different aspects of the relevant orientation while avoiding those aspects that the first analysis had indicated did not align with the construct. The original definitions of the orientations were vital during this process. The survey was again validated by the same three experts; minor changes were suggested and incorporated.

Version 2
All items loaded on the intended factors, except for two from the task orientation. Three new items were designed, and validated by the three physics education experts.

Version 3
Since four stable factors had been identified, four factors were requested in the final exploratory factor analysis. Items loaded as expected. The work avoidance orientation had three items and all other orientations had four or more items with factor loadings greater than or equal to 0.60. The reliability coefficients, Cronbach alpha, are shown in the last row of Table 2. It is widely accepted in social science that alpha should be greater than or equal to 0.70, so all factors are acceptable except for the work avoidance orientation, which should ideally have one more item with factor loading greater than or equal to 0.60.

Some preliminary findings

Factor scores were calculated by applying unit weighting to each item and then determining the average score for each student. This is the recommended method when a survey is used beyond the original sample (Gorsuch, 1983). Here we present two analyses of the survey.

Midway through second semester, students were invited to participate in focus groups to discuss their tutorial experience. Fourteen students from three different courses who all had knowledge of the two tutorial types volunteered. Regardless of course choice or high school physics background, all focus groups had very similar comments about the tutorials. The focus groups were transcribed and the data analysed using thematic analysis. The quotes here represent themes that demonstrate features in the preliminary quantitative findings.

Correlations
First we examine the correlations between the orientations in version 3 (see Table 3). The task orientation is the only orientation that correlates with *all* other orientations. The correlations, however, are quite small, with the exception of the negative correlation with work avoidance of medium effect size. This latter correlation indicates that students who aim to increase their own competence are generally not interested in engaging in work avoidance behaviour. Such a correlation is expected, as very few students would be under the illusion that they could increase their mastery of physics without investing any time or effort.

Table 3. Descriptive statistics and correlations for the four goal orientations in the final survey administered at the end of semester 2, 2008 (*N* = 162).

	Mean (SD)	Ego	Task	Cooperation	Work avoidance
Ego	3.08 (0.659)	1	$r = 0.164$, $p = 0.036$	$r = 0.139$, $p = 0.077$	$r = 0.066$, $p = 0.404$
Task	3.87 (0.478)		1	$r = 0.155$, $p = 0.049$	$r = -0.380$, $p = 0.000$
Cooperation	3.25 (0.689)			1	$r = 0.041$, $p = 0.601$
Work avoidance	2.31 (0.657)				1

The only orientation to exhibit correlations with all the other orientations, the task orientation also has the highest mean score. This reflects that, on average, students who responded appear keen to *learn and understand* physics, and that this desire is positively related to their attitudes towards performance and cooperation, and negatively related to their attitudes towards work avoidance. The correlations between the task, ego and cooperation orientations were supported by student feedback.

One high-achieving student showed clear interest in understanding the material and appreciated the value of her group members in this process, but she also wanted to do well in the examination.

[Q]uantitative questions are really good, cause they're what's gonna be in the exam, and if you do them in the tute (…) they're really, really useful in terms of future study (…) I find the demonstration questions, like where you're actually doing stuff, a bit of a letdown because you wanna know more than what you actually need to, but they [tutors] are like 'no, no, no, you can't do that', and then no one really understands it. (…) [In the ideal group] everyone kind of pools their knowledge in and you generally get most of the answers out. That's what's awesome about working in groups cause I totally get some bits but cannot do the others. (…) If I worked by myself, I'd be more inclined to just go 'Oh well, I'll just skip that one, I'll just skip that one'.

Some light was also shed on the type of work avoidance behaviour that was removed from our study, namely the type of work avoidance that results from students knowing the material already and therefore seeing no need to work.

I think there's two reasons why people [don't do work in group work situations]. I swapped groups one week because I had something on, and I was with a group of guys who were just like that. It's just because they understood it all so they were so bored with it, but they actually did get it. It just made complete sense to them, so like what's the point of doing something I can already do, it's too easy. So that's a fair call. But then a lot of the time when my group, kind of, shits around [sic] it's like, with electromagnetism, we have no idea. (…) how do you start when you can't even read the question? So it's kind of two extremes; people are not working because they completely don't get it or because they're just so bored they just don't care.

Temporal changes

We also examined how the mean ego and cooperation orientation scores changed with time, as both orientations had four items with factor loadings greater than or equal to 0.60 that occurred in *all* administrations. Using these four items only, it was found that the mean scores for each administration did *not* show much variation or any clear trends. As a representative subset, the 2007 results are shown in Table 4.

Table 4. Descriptive statistics, including standard error of the mean (SEM), for the ego orientation in the 2007 administrations using the four items that were retained in the final version.

Time	Class	Ego				Cooperation			
		N	*Mean*	*SEM*	*SD*	*N*	*Mean*	*SEM*	*SD*
Early sem 1, 2007	FND	119	2.85	0.068	0.738	119	3.53	0.060	0.653
	REG	239	3.01	0.052	0.810	242	3.46	0.041	0.634
End sem 1, 2007	FND	155	3.06	0.069	0.865	157	3.51	0.053	0.660
	REG	192	3.11	0.060	0.828	193	3.55	0.047	0.652

Data were collected at the beginning and end of first semester together with information about student enrollment. Two different classes were sampled: The Fundamentals (FND) class, which is designed for students with little or no prior formal physics instruction, and the Regular (REG) class designed for students with high school physics. Although no statistically significant differences were found, some trends deserve mentioning.

For the ego orientation, the means for both classes were higher at the end of the semester than at the beginning. This may suggest that students became somewhat more focused on examination performance as the semester progressed and they gained some experience with physics studies. That both Fundamentals and Regular students have a strong focus on the preparation for end-of-semester examination was very clear in the focus groups. When discussing the tutorial environments, a female Fundamentals student made the following comment:

Yeah, cause you know you're actually doing it for the exam. Like, in the end.

And a Regular female student responded in the following way:

Interviewer: What about the solutions handed out at the end. Do you ever go through them? Are they helpful?

Student: Yes. I think it's really helpful, but again, for the discussion part I want to know which part counts and why... is better, I think. Because you have a really long passage and you don't know which part is really important and which part is not that important. (…) I think, for me, I like the type of marking scheme style of solution rather than just a passage.

For the cooperation orientation it is difficult to say whether the changes seen are robust. However, what was noted across the focus groups was a great variety in student attitudes towards group work – some liked it; others didn't. In a focus group with three high-achieving students, group work received a mixed response.

Interviewer: Working in groups, is that helpful? (…)

Students A and B: Yes.

Student C: Yes and no. (…) it depends totally on the group and how everyone else is working. And if they're just talking and stuff, it can drag you down a bit, but if they're really smart it's good. [Students A and B agree] (…)

Student A: I think the perfect group is one slacker to keep it lighthearted, one flogger to keep everyone working, one person who's good at maths and one person who's good at visualising. That's like the ideal group.

Two Fundamentals students also disagreed on the usefulness of group work.

Student D: I think groups are good. Because, if there's something you don't know, and you're in a group of four, probability that someone else might know it is pretty high. So, it's good.

Student E: I learn less, cause I just talk to them about other things. (…) I find it easier to just work through it myself and just do it at my own pace.

A Regular student put it very clearly and succinctly:

In theory, the idea of having groups (…) is good, but when it comes down to it you really end up just talking together. I think group work is good, but it has its limitations.

Both classes showed medium to strong correlations between the early and end of semester scores for both orientations (Ego: FND: $r = 0.344$, $N = 87$, $p = 0.001$; REG: $r = 0.498$, $N = 135$, $p = 0.000$; Cooperation: FND: $r = 0.379$, $N = 85$, $p = 0.000$; REG: $r = 0.433$, $N = 138$, $p = 0.000$), and the correlations are stronger for the Regular students than the Fundamentals students. This suggests that the latter undergo more of a change in attitude towards performance than do those with high school physics experience.

Discussion

The Physics Goal Orientation survey was successfully developed for a tertiary physics context between 2006 and 2008. The survey was adapted from Duda and Nicholls' (1992) goal orientation surveys for year 11 students, which covered the topics of 'classroom' and 'sport'. The development covered three versions of the survey trialled with three different cohorts of first year university physics students across six administrations. The final survey includes 19 items that measure the four goal orientations *ego*, *task*, *work avoidance* and *cooperation*. The ego, task and cooperation orientations have five items each and have been confirmed by factor analysis to be statistically acceptably measures. The work avoidance orientation has only four items, but this may be due the relatively few responses to the final administration (N = 162) or a statistical anomaly. In future administrations of the survey, we recommend inclusion of the three items that were not retained for the final version to investigate whether these produce viable factor loadings in a different sample.

We report two sets of preliminary findings based on the survey data. Correlations between orientations showed found that the task orientation correlated statistically significantly with *all* other orientations; there were no other correlations in addition to these. Of particular interest is the small but positive correlation with the ego orientation, which suggestings that a desire to understand and learn material is weakly but positively associated with a goal to perform well. Such a correlation has been observed in other studies as well (Linnenbrink & Pintrich, 2001; Wolters, 2004). The medium strength negative correlation between the task and work avoidance orientations suggests that students who wish to learn physics are not interested in engaging in work avoiding behaviour. Theoretically, one would expect such a negative correlation, so this observation strengthens the validity of the instrument. Investigating the mean scores of the ego and cooperation orientations, no clear findings emerged; however, the data suggest that first year university physics students with a high school physics background have a slightly stronger performance focus (higher ego orientation score) than students without high school physics. This, however, may be the result of a selection effect in terms of who chooses to attend lectures and tutorials *and* complete the survey. Perhaps a broader selection of the students without high school physics feel compelled to attend lectures and tutorials due to their unfamiliarity with the subject, whereas those students who have studied physics before and do not have a strong ego orientation are more likely to not attend class?

A major strength of this study is the development of an instrument to measure tertiary physics students' goal orientations, which had not been found in literature. The survey was trialled and validated with several different cohorts and subsets of the first year students. A limitation of the study is that only four items were retained for the work avoidance orientation, only three of which had a factor loading greater than or equal to 0.60. (This may have been an anomaly in the last version of the survey, but it should be tested again when the survey is used to measure students' goal orientations.) The preliminary findings suggest avenues for further research.

Many interesting research questions can be pursued using the Physics Goal Orientation survey. In general, it would be valuable to characterise physics students' different goal orientations and the correlations between them. Are physics students similar to other groups of students? Are there differences between various sub-groups of physics students (e.g., majors vs. non-majors, third year vs. first year students)? Much research in secondary education has focused on how students' goal orientations correlate with academic performance. Most conclude that the ego orientation exhibits a positive correlation with academic performance, whereas there is generally no correlation with the task orientation (Senko & Harackiewicz, 2005; Elliot, McGregor & Gable, 1999). However, Grant and Dweck (2003) found that in an important and challenging university course mastery goals predicted higher grades. Thus, the deep-processing cognitive strategies associated with mastery goals may be essential for high achievement when the task has a high degree of challenge or when the processing of complex, difficult material is necessary. Is this the case for tertiary physics? Is there a negative correlation between work avoidance and performance? If so, can the work avoidance orientation be used as an indicator of students at risk of failing their course? In addition, do any of the goal orientations correlate with students dropping out of physics after one or two semesters (if they have this option)? It may also be valuable to pursue the interest orientation that emerged during our development of the survey.

As discussed in the Introduction, achievement goal theory is only one aspect of the broader field of motivation. It may be interesting to view further research into physics goal orientations in the context of a larger theoretical framework by including, for example, self-regulation theory and intrinsic and extrinsic motivation. Self-regulation is defined by Pintrich (2000, p. 453) as

"an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behaviour, guided and constrained by their goals and the contextual features in the environment".

In a university environment where students are expected to be independent learners, it is essential for their success that the students be self-regulated. Intrinsic motivation refers to behaviour performed purely out of interest without relation to external consequences, whereas extrinsic motivation is externally driven (Deci, Ryan & Williams, 1996). Considering how students' goal orientations are strongly affected by their learning environment and peers, one might even wish to study goal orientations from a sociocultural perspective (Walker, Pressick-Kilborn, Arnold & Sainsbury, 2004).

In summary, the newly developed Physics Goal Orientation survey measures the four main variables within the achievement goal theory in a physics specific context and demonstrated some disciplinary and local context features. The value of a Physics Goal Orientation survey for tertiary physics is evident from the suggested research questions above. Investigating physics students' goals can help us as teachers and researchers understand our students better and thereby tailor the way we design our courses to better suit our students' needs.

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References

Ames, C. (1992). Classrooms: goals, structures, and student motivation. *Journal of Educational Psychology, 84*(3), 261-271.

Anderman, E. M., Austin, C. and Johnson, D. (2002). The development of goal orientation. In A. Wigfield and J. Eccles (Eds.), *The Development of Achievement Motivation* (pp. 197-220). San Diego, CA: Academic Press.

Choi, N. (2005). Self-efficacy and self-concept as predictors of college students' academic performance. *Psychology in the Schools, 42*(2), 197-205.

Covington, M. V. (2000). Goal theory, motivation, and school achievement: An integrative review. *Annual Review of Psychology, 51*, 171-200.

Deci, E. L., Ryan, R. M. and Williams, G. (1996). Need satisfaction and the self-regulation of learning. *Learning and Individual Differences, 8*, 165-183.

Duda, J. L. and Nicholls, J. G. (1992). Dimensions of achievement motivation in schoolwork and sport. *Journal of Educational Psychology, 84*(3), 290-299.

Dweck, C. S. and Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, *95*(2), 256-273.

Elliot, A.J., McGregor, H.A. and Gable, S. (1999). Achievement goals, study strategies, and exam performance: A mediational analysis. *Journal of Educational Psychology, 91*, 549-563.

Field, A. (2000). *Discovering Statistics Using SPSS for Windows.* London: Sage Publications Ltd.

Floyd, F. J. and Widaman, K. F. (1995). Factor Analysis in the Development and Refinement of Clinical Assessment Instruments. *Psychological Assessment*, *7*(3), 286-299.

Gorsuch, R.L. (1983). *Factor analysis* (2nd ed.). Hillsdale, NJ: Erlbaum.

Grant, H. and Dweck, C. (2003). Clarifying achievement goals and their impact. *Journal of Personality and Social Psychology*, *85*, 541-553.

Lent, R. W., Brown, S. D. and Gore, P. A. (1997). Discriminant and predictive validity of academic self-concept, academic self-efficacy, and mathematics-specific self-efficacy. *Journal of Counseling Psychology*, *44*(3), 307-315.

Lindstrøm, C. and Sharma, M. D. (2008). Initial development of a Physics Goal Orientation survey using factor analysis. *Visualisation and concept development. Proceedings of the UniServe science symposium.* Sydney, NSW: UniServe Science, 60-66.

Linnenbrink, E. A. and Pintrich, P. R. (2001). Multiple goals, multiple contexts: The dynamic interplay between personal goals and contextual goal stresses. In S. Volet and S. Jarvela (Eds.), *Motivation in Learning Contexts: Theoretical Advances and Methodological Implications*. Oxford, UK: Pergamon, 251-269.

Meece, J. L., Anderman, E. M. and Anderman, L. H. (2006). Classroom goal structure, student motivation, and academic achievement. *Annual Review of Psychology, 57*, 487-503.

Nicholls, J. G., Cobb, P., Wood, T., Yackel, E., & Patashnick, M. (1990). Assessing Students' Theories of Success in Mathematics: Individual and Classroom Differences. *Journal for Research in Mathematics Education*, *21*(2), 109-122.

Pallant, J. (2001). *SPSS survival manual: A step by step guide to data analysis using SPSS for windows (Version 10)*. St Leonards, NSW: Allen & Unwin.

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich & M. Zeidner (Eds.), *Handbook of Self-Regulation*. San Diego: Academic Press.

Senko, C. and Harackiewicz (2005). Regulation of achievement goals: The role of competence feedback. *Journal of Educational Psychology, 97*, 320-336.

Shimoda, T., White, B. Y. and Frederiksen, J. R. (2002). Student goal orientation in learning inquiry skills with modifiable software advisors. *Science Education, 86*(2), 244-263.

Skaalvik, E. M. (1997). Self-enhancing and self-defeating ego orientation: Relations with task and avoidance orientation, achievement, self-perceptions, and anxiety. *Journal of Educational Psychology*, *89*(1), 71-81.

Streiner, D. L. (1994). Figuring out factors: The use and misuse of factor analysis. *Canadian Journal of Psychiatry, 39*, 135-140.

Urdan, T., Kneisel, L. and Mason, V. (1999). Interpreting messages about motivation in the classroom: Examining the effects of achievement goals structures. In M. Maehr & P. Pintrich (Eds.), *Advances in Motivation and Achievement* (pp. 123-158), Vol 11 (JAI Press).

Walker, R. A., Pressick-Kilborn, K., Arnold, L. S. and Sainsbury, E. J. (2004). Investigating Motivation in Context: Developing Sociocultural Perspectives. *European Psychologist, 9*(4), 245-256.

Wolters, C. (2004). Advancing achievement goal theory: Using goal structures and goal orientations to predict students' motivation, cognition and achievement. *Journal of Educational Psychology*, *96*, 236-250.