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ABSTRACT

Information feedback is widely believed to play an important role in cognitive processes such as monitoring and self-regulation. It has been linked to enhanced motivation and increased performance. Assisted by feedback, students confirm or change knowledge and modify cognitive processes for better performance. This study investigated self-selected information feedback provided by a computerized grade-tracking system used in a rural, central Pennsylvania junior high school. The effect of student use, parent use, and teacher use of the system on student academic achievement and motivation was examined. Findings support the assertion that motivated individuals sought out feedback in such a system and, in turn, performed better academically. In addition to exploring positive system effects associated with academic achievement motivation and student performance, implications for beneficial communication among parents, children, and teachers are discussed. (Contains 25 references.) (Author/MES)

The Effects of a Web-based Information Feedback System on Academic Achievement Motivation and Performance of Junior High School Students

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Abstract

Information feedback is widely believed to play an important role in cognitive processes such as monitoring and self-regulation. It has been linked to enhanced motivation and increased performance. Assisted by feedback, students confirm or change knowledge and modify cognitive processes for better performance.

In this study, we investigated self-selected information feedback provided by a computerized grade-tracking system used in a rural, central Pennsylvania Junior High School. Findings support the assertion that motivated individuals sought out feedback in such a system and, in turn, performed better academically. In addition to exploring positive system effects associated with academic achievement motivation and student performance, we discuss implications for beneficial communication among parents, children and teachers.

In recent educational research, it has been suggested that feedback is an inherent catalyst for all self-regulated activity (Butler & Winne, 1995). This feedback can exist in different forms and at many levels. Feedback can be created internally by a student, which is believed to occur when more effective learners engage in academic tasks. Indeed, the monitoring processes of such students generate internal feedback that describes the very nature of cognitive processing that led to them.

In a classroom, much feedback is generated from external sources, especially the teacher. Typically, this feedback amounts to identification of correct answers for assignment or test questions. It can also include affective-loaded recognition. Schommer (1990) suggests that in the context of self-regulated learning, considering feedback merely in the terms of its information is too simplistic. He contends that external feedback can spark a dynamic chain of events unique to the individual. Thus, understanding a particular student's perception and internalization of the feedback could be critical in determining its effect. Regardless of its form, feedback should be considered a significant variable in the self-regulatory processes that guide knowledge accumulation, tuning, and restructuring (Rumelhart & Norman, 1978).

Self-Regulation

Zimmerman (1989) defines self-regulation as "the degree to which individuals are metacognitively, motivationally, and behaviorally active participants in their own learning process" (p. 329). Guided by his or her goals, the self-regulated student is characterized as one who is aware not only of task requirements, but of personal need for optimal learning experience. Effective use of cognitive and metacognitive strategies, progress monitoring, and management of time and study environments are typically attributed to self-regulated students (e.g., Schunk, 1989).

Recent studies of self-regulation have focused on cognitive and metacognitive strategies and their direct enhancement of student learning. This line of research addresses cognitive strategies such as elaboration, organization, rehearsal of academic

material, and progress self-monitoring; all within the contexts of reading, note-taking, and test-preparation.

Goal-orientation and Motivation

The integration of goal-orientation theories with motivation research has produced different viewpoints on the nature and make-up of achievement goals. In particular, Dweck (1989) identifies two types of achievement goals: learning and performance. Distinguishable in terms of value, expectancy, and means value; these two types of achievement goals have received considerable attention in the recent literature.

Students who adopt learning goals seek expertise in a subject matter domain. In contrast, students who pursue performance goals strive to enhance their own and other's perception of personal task competence (Dweck, 1986). While both types of goals appear to involve pursuit of competence, previous research (e.g., Ames & Archer, 1988) has found that students who approach tasks with a learning goal-orientation report greater use of self-regulatory activities and deep cognitive strategies.

Renaming learning goals to mastery goals, Ames (1992) considers them to be necessary mediators of self-regulated learning. She points out key motivation-pertinent variables identified in recent research as associated with mastery orientation. This has linked mastery goal-orientation to: belief that effort leads to success (Weiner, 1979), pride and satisfaction with successful effort (Jagacinski & Nicholls, 1987), preference for challenging work and risk taking (Ames & Archer, 1988), intrinsic interest in learning activities (Butler, 1987), and positive learning attitudes (Ames & Archer, 1988).

Within this body of research, active student engagement in learning has been linked to the application of effective learning and problem-solving strategies. As stated before, it has been shown that those students who adopt learning or goal-mastery orientations, are more likely to believe that effort leads to success and that failure can be remedied by change in strategy (McCoombs, 1984). These ideas are key to the effective application of self-regulation theory in classroom situations.

Important External Influences to Goal-setting, Self-Regulation, and Motivation

Although student goals may be influenced by prior experience, achievement history (Wentzel, 1991), and parents (Ames & Archer, 1987); classroom practices influence the salience of particular goals and ultimately their adoption (Ames, 1992). The literature in this area suggests that the nature of learning tasks, evaluation practices, reward use, exercise of authority, and experienced responsibility all impact on motivation. These facets of classroom experience influence how students engage in learning, how they view personal ability, and the extent to which ability is an evaluated dimension within the classroom.

It is important to note that student perception of any aspect of classroom environment may or may not coincide with the perceptions of teachers or other school personnel. Perceptions may also vary from student to student in one classroom environment. Thus, to predict and examine student cognitive motivation, affect, and behavior, it is necessary to consider their attribution of meaning to classroom experience. The importance of student perception of classroom climate and structure is evident in recent literature by a shift from observational approaches to the study of classroom processes.

In this investigation, we focused on the evaluation and recognition aspects of classroom structure. How students are evaluated is one of the most significant classroom factors affecting student motivation (Ames, 1992). Evaluation practices studied (Epstein & Mac Iver, 1990) for their influence on student learning include standards, criteria, methods, frequency of evaluation, and content of evaluation.

While grades are the most common means of coding evaluative outcome in public schooling, they are not without problem. Grading has been shown to foster unwanted social comparison in a classroom environment (Butler, 1987), causing students to focus more on ability than effort. However, when social comparison is reduced or eliminated, sometimes by accompanying grades with the opportunity to improve, then effort becomes a stronger self-evaluative factor (Covington & Omelich, 1984). Graham and Golan (1991) have shown that when students focus on self-improvement rather than comparison

with others, they exhibit better recall of material. It is suggested, therefore, that for the most effective learning to occur, teachers should utilize grades in ways that track individual learning effort, focus on self-improvement, and minimize normative frames of reference.

As technology has created new opportunities, a particular aspect of grades that invites investigation is the method by which they are provided to the students. Grades are feedback, particularly when treated as information, which can lead to improvement.

The Information Feedback System Under Investigation

The system we investigated was used during the 1999-2000 school year in a regional junior high school located in rural, small-town Pennsylvania. It was based on and utilized a unique, fully real-time software program that had been created over several years using 4th Dimension application development tools. "TigerNet" was named by the students for the school's mascot. Through WEB and within-building client interfaces, TigerNet provided confidential 24 hour, seven-days-a-week outcome feedback to students on expectation for and outcomes of their academic performance. All academic courses were included. Utilizing the quickly-executed format they had shaped over the previous few years, teachers entered specifications for each task, as well as performance outcome information (grades). Time to accomplish this compared most favorably with any previous method, electronic or manual, they had used for handling the same sort of information. Students and their parents – all of whom had personal, appropriate-delineated accounts – had continuous access to time-grounded information that allowed determination of evolving grade status and identification of upcoming tasks. In addition, an electronic mail system was included in the program, allowing communication between students, teachers, and parents.

TigerNet information was available to students through networked microcomputers in each of the classrooms, the library, computer labs, and the guidance office. Students had account names and passwords to log into the system. There were provided within-building access to the system at different times during the school day,

secondary to the organizational structure of building. Grade-tracking reports and task specifications could be printed from several printer locations. This allowed students to take records home for personal use and to share with parents. The most frequently used system functions were associated with checking graded work and tracking still-outstanding assignments.

Use of the TigerNet system was grounded in self-initiative. No student was forced to utilize it to check on grades or assignments. The system aimed to increase student ownership and responsibility in the learning process.

While not all students used it to the same extent and for the same apparent reasons, ultimately the TigerNet system did provide access to timely evaluative information and continuous opportunity to track achievement on all solid-subject academic tasks. In this investigation, we focused on associations between student academic achievement motivation and self-selection of performance feedback during TigerNet system use. Even though it played no direct role in instructional activity, per se, it was hypothesized that TigerNet use would facilitate ongoing instruction and learning by providing students with an effective way to obtain academic feedback. Within this theoretical framework, the impact of the system on academic performance for a particular student would depend on his or her perception of the feedback meaning, feedback value, motivation to succeed academically, and goal-orientation. Thus, we hypothesized that student use of the TigerNet system would have an indirect but positive effect on academic motivation and performance.

As a secondary consideration, we investigated the possible impact of TigerNet on parental involvement in their child's education. It is generally accepted that parents play an important role in guiding, facilitating, and motivating their child's learning. Yet, with the changing make-up of our nation's families, it has become an increasingly difficult and stressful task for many parents to find the time to involve themselves in their child's education (Waddock, 1995). It was hypothesized that the simple existence of TigerNet would provide new and better opportunity for parents to become involved in their child's education.

Access to the TigerNet system allowed parents to have quick, powerful access to information about their child's daily activities and performance in school. It was believed this would create opportunity for parents to engage in discussions with their child about schoolwork, help their child in problem areas, render astute praise, and generally motivate their child to succeed academically. Because parents could be more informed about academic performance on an up-to-date basis, it was hypothesized that TigerNet could potentially facilitate communication among parents, teachers, and other school officials.

Methodology

Given the theoretically indirect connection between TigerNet use and student performance it was determined that a correlational design would be most appropriate. Specifically, an attempt was made to examine what effect student use, parent use, and teacher use of TigerNet had on student academic achievement and motivation.

Our theoretical model used the following variables and operational definitions:

Student Academic Achievement: was the only dependent variable that was a function of all other variables, directly or indirectly. Student academic achievement was measured as a core-course GPA (CGPA). Specifically, each student's grades in science, math, English, and social studies at the end of the 3rd marking period were averaged to generate a final 3rd marking period CGPA. Each core subject teacher reported a grade on a scale from 0 to 100, indicating the percent of points earned. These teachers had an overall belief that the 3rd marking period was the most vital and representative of the school year. Therefore, we hypothesized that 3rd marking period CGPA would be most affected by TigerNet use.

Academic Achievement Motivation: was measured with a modified version of Russell's (1969) School Achievement Motivation Scale. Possible scores on this measure ranged from 0 to 29. This measure was administered in class in the beginning of the school year in order for it to serve as a control variable. It was also administered at the end of the

school year. It was hypothesized that achievement motivation would be influenced by student TigerNet use and would predict academic achievement.

Parental Involvement: Parent involvement in the education of their child was measured with a scale developed by Keith et al. (1993). Possible scores on this measure ranged from 0 to 16 and were hypothesized to predict both student academic motivation and achievement.

Prevalence and Frequency of Student TigerNet Use: was measured by total time (in minutes) spent using the system and total number of system actions taken by each student throughout the academic year. It was hypothesized these variables would be influenced by initial student academic motivation. Further, it was hypothesized they would predict academic performance and end-of-school-year motivation. The system recorded this data automatically in its internal logs.

Prevalence and Frequency of Teacher TigerNet Use: was measured by total time (in minutes) spent using the system and total number of system actions taken by each teacher throughout the academic year. Both variables were hypothesized to predict academic performance. Once again, the system automatically recorded this data in its internal logs.

Complete data sets for the variables in the model were obtained for 476 students of the approximately 1,000 students enrolled in the junior high during the 1999-2000 school year. Data for all variables were submitted to a series of path analyses using the EQS computer program (Bentler, 1997). After evaluating sampling adequacy and model identification sufficiency, the variance/covariance matrix for the variables with available data was submitted to EQS to estimate path coefficients and fit statistics.

With respect to the secondary consideration of parental involvement, an open-ended survey was sent to parents to assess perception of system capability to facilitate school/parent communication and general involvement. Content analysis of written feedback was performed using N-Vivo software (Fraser, 1999; Qualitative Solutions and Research Pty. Ltd., 1999) to generate data on frequency of comment type.

Results and Discussion

Distributions of both prevalence and frequency of student system use revealed strong, positive skewness. While the majority of students spent between 100-200 minutes and initiated approximately 100 unique actions within the TigerNet system for the academic year, there were a few students who spent well over 1,000 minutes and initiated over 500 unique actions. In order to secure statistical assumptions and maximize analytical power, we performed a natural logarithmic transformation of these two variables. The resulting distributions of $\log_n$-transformed scores were substantially normalized and were used in the path analysis.

A graphic depiction of the model with path coefficients and fit statistics is shown in the Figure 1. Note that "Student Time On" and "Student Actions" are natural log-transformed scores.

Insert Figure 1 Here

Table 1 provides a summary of all fit statistics examined. The preponderance of these values supports an assertion that the model in Figure 1 matches the empirical data quite well.

Insert Table 1 Here

After controlling for academic achievement motivation, a significant positive association was found between total time students spent using the TigerNet system and CGPA. At the same time, however, a negative association was found between total number of actions and CGPA.

We can speculate why this happened. Certain student actions, especially receiving and sending email, may have taken longer to execute and been related more strongly to academic performance. Other actions, such as checking to see if late assignments have been credited, probably occurred more frequently and quickly, and may have been more typical of lower performing students. In any event, understanding these particular findings is not possible with the data collected in this study and will need to await future studies.

It is important to note that prior motivation was found to have an effect on the total amount of time a student spent using TigerNet. Those students scoring higher in achievement motivation tended to use the TigerNet system more. This finding supports the notion that more motivated individuals engage in more self-regulatory behavior that promotes learning. Actively seeking information about daily academic progress and responsibilities points to self-regulating students seeking to attain academic goals.

In the path model, parental involvement was not related directly to academic achievement or to student use or teacher use of the system. However, it did have a small impact on end-of-year student academic achievement motivation. Beginning-of-year and end-of-year student academic motivation were both related to academic achievement. Finally, though teacher time spent on TigerNet was not related to variables in the model, the frequency of their TigerNet actions was related significantly to the amount of time students spent using the system.

Of the 980 surveys sent to parents, approximately 265 came back, for a return rate of 27%. However, not all parents responded to every question resulting in different response totals from question to question. Although it could not be determined if those who responded were representative of the entire set of parents, this information was still deemed useful. It was viewed as a source of potentially important themes and revealing information for future consideration during system operation.

The first two questions on the survey were included to help clarify how often and the manner in which parents accessed TigerNet information. A total of 200 parents (81% of respondents to this question) indicated that they accessed TigerNet information in

some manner, and 91 parents (47.6% of respondents to this question) asserted that they used TigerNet information at least once a week.

Responses to the remaining five, open-ended survey items were converted to a text format and submitted to a standard content analysis. These questions were:

3. What did you like most about TigerNet?
4. What are some problems you encountered in using TigerNet?
5. How do you think TigerNet might be improved?
6. Has TigerNet changed the way you interact with your child? If so, how?
7. Did TigerNet change the way you interact with the Junior High School? If so, how?

Five major themes arose naturally from the content analysis of parent responses. These themes, referred to as "parent nodes" in the content analysis, are Positives, Negatives, Improvements, Child Interaction, and School Interaction. Under each of these, several more specific "child nodes" were detected in the content analysis. A total of 772 comments were coded from the entire set of parent responses. The description of each theme and the number of comments associated therewith follows.

General positive comments: Two hundred and forty-eight (248) general positive comments were identified and categorized into 4 groups. The overwhelming majority of comments concerning TigerNet "positives" fell under the theme of "More Informed." Two hundred and twelve (212) comments indicated that having access to TigerNet allowed parents to feel more informed about their child's education. The majority of these comments referred to having more information concerning grades and assignments. Examples include:

- "I could check on my daughter's progress and know what was going on."
- "TigerNet made it easier to know if my child had gotten a little lazy about studying so we could get him back on track before his overall grade dropped."

Twenty-four (24) comments indicated that parent access to TigerNet information increased child responsibility for academics. Examples include:

- "It got my child more involved with school and a better chance for us to not let them slip behind."
- "It empowers students to monitor and take responsibility for their work."

Seven comments indicated that TigerNet had a direct impact on grade improvement. Examples include:

- "Daughter saw progress all year long."
- "My daughter decided she wanted to improve her algebra grade form 3rd to 4th semester, through constant checking her grade improved from 79 to 92."

Five comments indicated that TigerNet had a direct impact on student organization in school. Examples include:

- "My son is not very organized. We have been trying to monitor his use of a homework assignment book and how promptly he turns in assignments. TigerNet had helped us to do this to a certain extent."
- "...helped my son become slightly more organized and responsible for own assignments."

General negative comments: One hundred and ninety-seven (197) comments were considered negative and classified into 6 categories. The overwhelming majority of comments concerning TigerNet "negatives" fell under the theme "Lack of Update." Eighty-seven (87) indicated that some teachers did not update academic information on the system satisfactorily. Examples include:

- "It's caused friction because I saw work completed at home yet many assignments would stay (Missing) on TigerNet."
- "Teachers not keeping TigerNet up-to-date. New scores sometimes took a long time to get put into the system."

Forty-four (44) comments identified problems with logging into the system. There appeared to be two *distinct* issues here: difficulty with parent account login and difficulty accessing the system at certain times. Examples include:

- "Sometimes my password didn't work. Log-in/user mix-up."
- "Early in the year, it was hard to get on."

Thirty-five (35) comments concerned other technical difficulties encountered using TigerNet. Many of these indicated that the system was inoperable or "down" during times of attempted use. Examples include:

- "System was frequently down."
- "At times the system did not work properly."

Fourteen comments indicated that the environment of the system was not optimal. Examples include:

- "Not interactive"
- "Getting between screens was cumbersome, should be able to go from one to other instead of backing to main."

Twelve comments noted problems with the email feature of TigerNet. Two email issues were present, some technical problems with the system's email server and lack of use or prompt response by teachers to parent emails. It also appeared evident from a few responses that not all parents knew they had the ability to email teachers. Examples include:

- "Had trouble sending emails."
- "The new email feature set up this year has not been fully explained regarding communicating with parents."

Five comments stated that the TigerNet system was "slow." Examples include:

- "Slow loading information, we have 56k modem."
- "The program is really slow."

System Improvement comments: One hundred and twenty-three (123) suggestions addressed system improvement. They were categorized into 6 areas. Fifty-two (52) comments asked for teacher accountability in updating system information. Examples include:

- "Assure that teachers keep grades as up-to-date and accurate as possible"
- "By making a rule that all grades and assignments due need to be updated by Friday of each week. I could then have (student name) print out a report each Friday and know it will be accurate."

Two comments identified strategies to help alleviate the problem of teachers not keeping system information current. These comments were:

- "Teachers or someone to help teachers because they are busy. Hire someone to handle inputting information for teacher."
- "Make simpler possibly for teachers to use so that they are more likely to keep it updated."

Forty (40) comments suggested ways to make the TigerNet system environment more usable. These included:

- "Restructure to be more "windows" oriented and user friendly"
- "Able to check multiple courses at same time or in procession without returning to main menu."

Twelve comments requested that additional information be made available through TigerNet. Examples include:

- "Add attendance and tardiness so we as parents can be sure students are attending"
- "Provide up-coming school events. Staff could provide up-coming major project information. Also maybe a messaging board for parents and teachers."

Twelve comments suggested activating TigerNet in the other schools within the district, specifically the senior high school. Five comments recommended additional information and/or training for parents to help them use TigerNet. Examples include:

- "The concept is great but everyone needs more training"
- "I feel at parent/teacher orientation would be a great time for further explanation."

Improved involvement in child's school work: One hundred and twelve (112) comments suggested that the system had improved parent involvement in the child's school work. When parents were asked if TigerNet had an impact on the way they interacted with their child, three themes emerged. The most frequent of these (48 comments) contended that TigerNet provided an opportunity to spend "time together" reviewing and discussing experiences and progress in school. Examples include:

- "It gave us more time to talk over school work and spend more time together."
- "A positive interaction. He enjoys having me check and always likes to tell me about assignments listed."

Almost as frequent (45 comments) was the theme that TigerNet "increased accountability and trust" between parents and children with regard to academic work. Examples include:

- "I think it keeps the kids on their toes knowing you can access grades at any time."
- "It helped bring more trust."

The third theme in this area asserted that TigerNet provided necessary information, as well as opportunity, for parents to "help the child with their schoolwork;" important assistance not possible without TigerNet. Nineteen (19) comments fell into this area and examples include:

- "We know what's going on at all times and are able to help in subjects that are lacking something."
- "I can see what my son is having problems with in school and help him right away until waiting for report cards to come out."

Improved parent-teacher communication: Ninety-two (92) comments suggested that the system had improved communication between parents and teachers. When parents were asked if TigerNet had an impact on the way they interacted with the school, two themes emerged. Forty-nine (49) responses cited "quicker communication." Most of these observed that TigerNet allowed parents to achieve quicker, more efficient communication with school officials about work and progress in school. Examples include:

- "TigerNet reveals much quicker as to whether there is an academic problem arising."
- "I did make the efforts to contact the guidance counselor and set up meetings with the teachers. I'm not sure if they would have ever contacted me, therefore, having the knowledge from the TigerNet really impacted my experience in a positive way for the school year."

Forty-three (43) comments were associated with "teacher contact." The comments in this theme were slightly different than "quicker communication." They suggested that TigerNet provided important information that enhanced traditional communication between parents and teachers. The email feature of TigerNet was reported often to be a positive vehicle for this communication. Examples include:

- "Without TigerNet I could never have communicated as easily with the teachers. It made me feel connected!"
- "I used the email to contact (student name)'s teachers. I found this easier and I didn't feel like I was "bothering/interrupting" a class. We have a better idea for the style of each teacher and their goals for the students."

Overall, content analysis findings from their survey responses indicated parents were quite supportive of the system. They reported that TigerNet increased student

responsibility while keeping parents better informed of their children's schoolwork. Parents contended that TigerNet helped them to be more involved in their children's schoolwork, increased trust, supported an increase in parental assistance with homework, and generally helped increase time spent together with their children. Lastly, parents reported that TigerNet fostered better, quicker communication with teachers and school officials.

Conclusions

It can be predicted with some assurance that computer-mediated handling and use of academic performance information by teachers, students, and parents will increase. While more research is needed regarding the use of technology in evaluation and feedback within the teaching-learning-assessment process, findings reported here for a pioneering system (TigerNet) provide empirical evidence that motivated students spend more time using such a system and perform better academically. This type of Web-based information feedback system has been shown to have beneficial implications not only for student achievement motivation and academic performance, but also for communication among parents, their children, and the school.

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Figure 1. Final path model

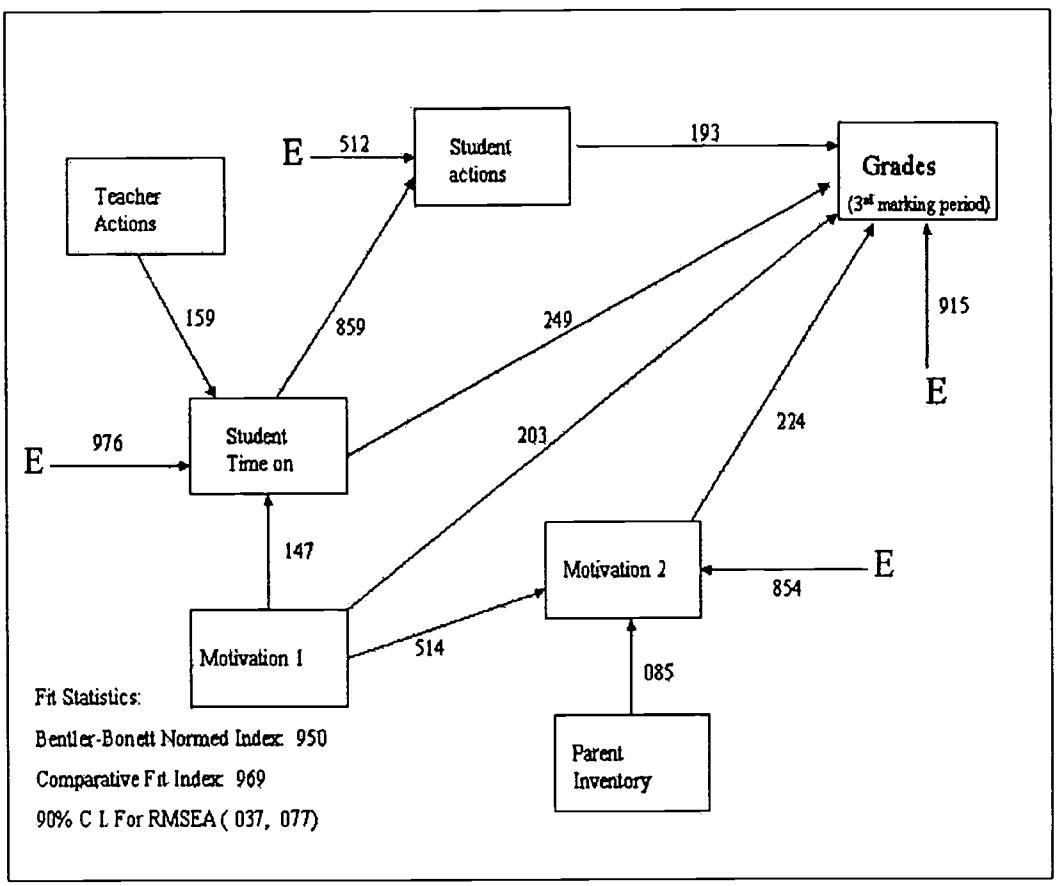

Table 1. Fit Statistics for Final Model Depicted in Figure 1

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INDEPENDENCE MODEL CHI-SQUARE = 950.998 ON 28 DEGREES OF FREEDOM
INDEPENDENCE AIC =   894.99772   INDEPENDENCE CAIC =   750.36602
       MODEL AIC =     9.91173          MODEL CAIC =   -88.23120

CHI-SQUARE =       47.912 BASED ON    19 DEGREES OF FREEDOM
PROBABILITY VALUE FOR THE CHI-SQUARE STATISTIC IS LESS THAN 0.001
THE NORMAL THEORY RLS CHI-SQUARE FOR THIS ML SOLUTION IS 48.098.

BENTLER-BONETT NORMED    FIT INDEX=       0.950
BENTLER-BONETT NONNORMED FIT INDEX=       0.954
COMPARATIVE FIT INDEX (CFI)       =       0.969
BOLLEN (IFI)             FIT INDEX=       0.969
McDonald (MFI)           FIT INDEX=       0.970
LISREL GFI               FIT INDEX=       0.963
LISREL AGFI              FIT INDEX=       0.931
ROOT MEAN SQUARED RESIDUAL (RMR)  =  425625.574
STANDARDIZED RMR                  =       0.047
ROOT MEAN SQ. ERROR OF APP.(RMSEA)=       0.057
90% CONFIDENCE INTERVAL OF RMSEA (       0.037,       0.077)
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