

# Personality: A Key to Motivating our Learners

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## INTRODUCTION

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The Motivation Assessment Tool (MAT), currently in development (Lameier et al, pending) will assess a learner's motivation profile and provide instructional guidance via the Generalized Intelligent Framework for Tutoring's (GIFT's) authoring tool to enable an instructor to design a lesson that will personalize the learner's experience to support and/or improve their motivation. Specifically, the MAT will provide a methodology for personalizing learning in GIFT. Learner motivation is influenced by a variety of traits and factors, which include student personality, learning performance history, intrinsic vs. extrinsic motivation tendencies, and self-regulatory skills (Reinerman-Jones et al., 2017). Understanding a learner's composition of these traits is key to tailoring the instructional environment to support and encourage learner motivation. Intelligent tutoring systems provide a learning environment in which it is possible to seamlessly assess and tailor instruction to support the learner's motivation. The goal for the MAT is to develop a method for identifying the motivational dispositions of GIFT learners. In turn, assessments using the MAT may guide methods for personalizing training to capitalize on the learner's motivational profile with the outcome being improved mastery and retention. This paper will describe an effort in support of the MAT's development and validation to determine how strongly a learner's personality profile describes their motivation. After discussing the analysis of the personality relation to the MAT, the paper will then focus on how the MAT will be implemented in GIFT and the associated benefits and the barriers.

### Motivation in Learning

Motivation has been defined as being "moved to do something" (Ryan & Deci, 2000) and is essential to learning (Keller, 1987). When in a motivated state, a learner is inclined to initiate a task and persevere throughout its completion. As a result, motivation increases an individual's level of engagement (Magill, 1980). When learners are not motivated, they are more likely to disengage from the task. Motivation can be classified into two types (delSoldato & duBoulay, 1999; Kember, Wong, & Leung, 1999; Noels, Clement, & Pelletier, 1999): (1) intrinsic motivation, which refers to an individual's internal desire to achieve, and (2) extrinsic motivation, which refers to external rewards that encourage an individual to achieve. Both intrinsic and extrinsic motivation are approached by the MAT as traits. However, intrinsically motivated individuals rely on self-regulatory processes and internally driven incentives, whereas extrinsically motivated individuals need an instructor or automated learning environment to influence their motivation throughout learning.

### Personality in Learning

An individual's personality traits influence their cognitive, affective, and motivational processes (Matthews & Zeidner, 2004; Blickensderfer et al, 2003). Consequently, a learner's personality profile will affect their reaction and experience with different learning environments and strategies (Komarrajuq et al, 2011; Costa & McCrae, 1992). The Big Five model (Goldberg, 1981) is one of the most commonly used personality theories. The five traits are: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness. Extraversion is related to an interest in social events, talking with others and interaction with environments. Agreeableness refers to a cooperative disposition with little interest in competition, a willingness to put others first, being compliant, and trusting others. Conscientiousness refers to behaviors that focus on attention to details, organization, and being goal-directed. Neuroticism describes a tendency to exhibit negative

emotions such as stress, anxiety, irritability, or sadness due to a predisposition to perceiving the environment as negative or threatening. Openness describes an inclination to explore, try and learn new things, and enjoy intellectual and creative activities.

The “Big Five” personality traits have been connected to behaviors, academic achievement, and job performance (Judge et al., 2007; Larson et al., 1990). Further, learners with intrinsic motivation, which refers to an internal desire to succeed, are more likely to have a high level of the personality trait Conscientiousness (Duckworth et al, 2007). Komarraju and Karau (2009) found that Conscientiousness was the most influential trait and had positive correlations with intrinsic motivation and high GPA, while correlating negatively with extrinsic motivation and amotivation. They also obtained evidence that individuals with: 1) high intrinsic motivation also had higher tendencies towards Openness, 2) high Neuroticism was seen to have a higher amotivation, and 3) high Extraversion was more closely associated with extrinsic motivation. The authors obtained similar results in a later, related study (Komarraju et al., 2011).

## **MAT WAVE 3 ANALYSIS**

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The MAT was developed to evaluate the multiple variables that influence a learner’s motivation to increase the precision in providing learning in GIFT tailored to the learner’s needs. The MAT has been constructed with two sections: 1) General Motivation, to assess the learner’s motivation traits, and 2) Motivator Inventory, to determine the optimal reinforcers that motivate the individual learner (see Table 1). The MAT development has undergone three waves of data collection and analysis. The first wave evaluated the original iteration of the MAT, which was created by combining and clustering items from prior motivation assessments, which each addressed a limited set of motivation variables (Reinerman-Jones et al, 2017). Additional items were created and included in this first iteration to evaluate the types of reinforcers that support an individual’s motivation. In the second iteration, two scales for items important to motivation, attitudes and autonomy, were added to ensure these constructs were addressed by the MAT (Lameier et al, pending publication). This paper focuses on the third wave analysis, which was used to: 1) check reliability and factor structure, and provide the final refinement to the MAT, and 2) evaluate relationships between the MAT scales and the Big Five personality traits.

**Table 1. MAT Scales**

<b>General Motivation</b>		<b>Motivator Inventory Scales</b>	
1. Attitudes	10. Workload	1. Feedback	10. High-value
2. Learning Driven	11. Organize and Structure	2. Intrinsic feedback	11. Self-reward
3. Autonomy	12. Social	3. Extrinsic feedback	12. Activity
4. Goal Orientation	13. Breaks	4. Recognition	13. Time
5. Loss of Effort	14. Extinction	5. IMI	14. Sensors
6. Worry	15. Relatedness	6. Digital	15. Hobbies
7. Freeze, Fear, Flight	16. Effort Based on Punishment	7. Energizer	16. Time During learning
8. Competition	17. Positive outlook	8. Logical Consequences	17. Negative Time
9. Challenge	18. Self-regulation	9. Low-value	18. Activity

## Participants

For the wave 3 analysis, 249 participants (112 females, 137 males) were recruited through Amazon Mechanical Turk, with ages ranging from 19 to 71 years.

## Materials and Procedures

The participants completed the MAT, along with the the Big Five Aspect Scales (BFAS; DeYoung et al, 2007) to assess the Big Five personality traits, the Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ; Corr & Cooper, 2016), and three assessments that evaluate aspects of motivation, which were the Portrait Value (Schwartz & Butenko, 2014), Grit and Ambition scale (Duckworth, 2009) and the 3x2 Achievement Goal scale (Elliot, Murayama, & Pekrun, 2011). The MAT contained 293 items across both sections of the MAT (general and motivator inventory). All of the questionnaires, including the MAT, were loaded into GIFT as evaluations. When the participants accessed Mechanical Turk, they were taken to GIFT via a weblink to complete the questionnaires. This paper is only addressing the evaluation of the relationships between the MAT and personality, while the evaluation of the MAT against the constructs evaluated by the other tools (e.g., grit, value, goal orientation) will be reported in subsequent publications.

## Results

First, Cronbach  $\alpha$  coefficients were calculated to evaluate the internal consistency of the scales identified in Table 1. The coefficients ranged from .794 (relatedness) to .955 (Freeze, Fear, Flight) in the General Motivation section and .791 (Intrinsic Feedback) to .935 (Recognition) in the Motivator Inventory indicating that each of the scales generally had satisfactory internal consistency.

Table 2. BFAS Scales

<b>Big Five Personality Trait</b>	<b>Trait Dimensions</b>
<b>Neuroticism</b>	<ul style="list-style-type: none"><li>• <i>Volatility</i> – tendency for extreme variability in response to external environment</li><li>• <i>Withdrawal</i> – tendency to focus inward</li></ul>
<b>Agreeableness</b>	<ul style="list-style-type: none"><li>• <i>Compassion</i> – interest in feelings of others</li><li>• <i>Politeness</i> – tendency to treat others with respect</li></ul>
<b>Conscientiousness</b>	<ul style="list-style-type: none"><li>• <i>Industriousness</i> – tendency to work hard to complete tasks</li><li>• <i>Orderliness</i> - detailed and organized nature</li></ul>
<b>Extraversion</b>	<ul style="list-style-type: none"><li>• <i>Assertiveness</i> – tendency to dominate social interactions</li><li>• <i>Enthusiasm</i> – tendency to exhibit energy and positive attitude</li></ul>
<b>Openness</b>	<ul style="list-style-type: none"><li>• <i>Openness</i> – willingness to explore new ideas and activities</li><li>• <i>Intellect</i> – tendency to synthesize information to guide, objective decision making</li></ul>

To simplify the analysis, an exploratory factor analysis was conducted to determine the higher-order factor structure of the MAT General Motivation scales. A principal factor method was used for factor extraction, followed by oblique rotation using the direct oblimin criterion. The three primary factors identified were Social (need for social interaction and competition), Self-Directed Learning (ability to keep on task and determine appropriate use of time to complete learning tasks), and Threat Vulnerability (tendency to become anxious or stressed during learning). On the basis of the scree test and parallel analysis three factors

were extracted, explaining 65 % of the variance. The range of factor correlations was maximum of .891 and minimum of .508. The three factors were then scored by their mean. The Social factor included scales from challenge, extinction, competition, relatedness, social link, and punishment. The Self-Directed Learning is composed from the autonomy, positive outlook, self-regulation, organized structure, and break scales. Threat Vulnerability has loss of effort, workload, worry, and fear-freeze-fight scales. A similar process was performed for the MAT Motivator Inventory and two primary factors were identified. The factors identified for the Motivator Inventory were Motivator (preference for specific type of reinforcer) and High Value Motivator (preference for reinforcer of high value). Based on the scree test and parallel analysis two factors were extracted, explaining 59% of the variance. The motivator scale was created by intrinsic feedback, extrinsic feedback, acknowledgement, digital, energizer, logical consequence, low value, self, activity, sensor, hobby, level of interactivity, and time during learning scales. The high value factor was the only factor that loaded on the high value scale. The range of factor correlations was a maximum of .814 and a minimum of .478.

**Table 2. Higher Order Factors**

	<b>Primary Factors</b>	<b>Correlations (<i>r</i>) with Personality Traits and Facets</b>	
<b>General Motivation</b>	<i>Social</i>	<ul style="list-style-type: none"> <li>• Neuroticism (.204)</li> </ul>	<ul style="list-style-type: none"> <li>• Agreeableness (-.276)               <ul style="list-style-type: none"> <li>○ Politeness (-.407)</li> </ul> </li> </ul>
	<i>Self-Directed Learning</i>	<ul style="list-style-type: none"> <li>• Openness (.554)               <ul style="list-style-type: none"> <li>○ Intellect (.529)</li> <li>○ Openness (.478)</li> </ul> </li> <li>• Agreeableness (.465)               <ul style="list-style-type: none"> <li>○ Compassion (.456)</li> <li>○ Politeness (.373)</li> </ul> </li> <li>• Neuroticism (-.335)               <ul style="list-style-type: none"> <li>○ Withdrawal (-.311)</li> <li>○ Volatility (-.322)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Conscientiousness (.457)               <ul style="list-style-type: none"> <li>○ Industriousness (.403)</li> <li>○ Orderliness (.384)</li> </ul> </li> <li>• Extraversion (.373)               <ul style="list-style-type: none"> <li>○ Enthusiasm (.396)</li> <li>○ Assertiveness (.253)</li> </ul> </li> </ul>
	<i>Threat Vulnerability</i>	<ul style="list-style-type: none"> <li>• Neuroticism (.730)               <ul style="list-style-type: none"> <li>○ Withdrawal (.714)</li> <li>○ Volatility (.663)</li> </ul> </li> <li>• Openness (-.485)               <ul style="list-style-type: none"> <li>○ Intellect (-.575)</li> <li>○ Openness (-.226)</li> </ul> </li> <li>• Agreeableness (-.437)               <ul style="list-style-type: none"> <li>○ Politeness (-.386)</li> <li>○ Compassion (-.398)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Conscientiousness (-.467)               <ul style="list-style-type: none"> <li>○ Industriousness (-.650)</li> </ul> </li> <li>• Extraversion (-.438)               <ul style="list-style-type: none"> <li>○ Enthusiasm (-.418)</li> <li>○ Assertiveness (-.340)</li> </ul> </li> </ul>
<b>Reinforcer Inventory</b>	<i>Motivator</i>	<ul style="list-style-type: none"> <li>• Extraversion (.321)               <ul style="list-style-type: none"> <li>○ Enthusiasm (.300)</li> <li>○ Assertiveness (.257)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Openness (.234)               <ul style="list-style-type: none"> <li>○ Openness (.237)</li> <li>○ Intellect (.201)</li> </ul> </li> </ul>
	<i>High Value Motivator</i>	<ul style="list-style-type: none"> <li>• Openness (.371)               <ul style="list-style-type: none"> <li>○ Openness (.371)</li> <li>○ Intellect (.322)</li> </ul> </li> <li>• Agreeableness (.347)               <ul style="list-style-type: none"> <li>○ Compassion (.311)</li> <li>○ Politeness (.310)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Conscientiousness (.329)               <ul style="list-style-type: none"> <li>○ Orderliness (.357)</li> <li>○ Industriousness (.214)</li> </ul> </li> <li>• Extraversion (.164)               <ul style="list-style-type: none"> <li>○ Enthusiasm (.201)</li> </ul> </li> </ul>

A bivariate correlation analysis was conducted to examine the relationships of the other motivation assessments' scales and the IPIP scales. Table 2 provides the Pearson correlation coefficients ( $r$ ) for IPIP scales for each of the MAT higher order factors. There were notable correlations for the primary factors for the both the General Motivation and Motivator Inventory sections of the MAT.

Threat Vulnerability demonstrated the strongest correlations with the Big Five personality traits and the 10 facets. The strongest, and only positive correlation, was with Neuroticism ( $r = .730$ ) and its facets Withdrawal (.714) and Volatility (.663). This type of learner would view the learning environment as intimidating making it difficult for the learner to maintain motivation due to feelings of hopelessness and likely have random reactions based on their successes and failures during the learning process. Threat Vulnerability was negatively correlated with the other 4 Big Five personality traits, indicated that this type of learner is most influenced by their predisposition to interpret their learning environment negatively. The strongest negative correlations were with the facet of Industriousness (Conscientiousness,  $r = -.650$ ) and Intellect (Openness,  $r = -.575$ ), reflecting a learner that is not productive due to their tendency to worry and their reluctance to experience new activities and experiences.

Self-Directed Learning was positively correlated with Openness ( $r = .516$ ) and its two facets, Openness ( $r = .592$ ) and Intellect ( $r = .470$ ). Given that Self-Directed Learning refers to an individual with an intrinsic motivation tendency and ability to complete learning tasks on their own, it makes sense that this type of individual would be open to new ideas and experiences. Self-Directed Learning was also correlated with Conscientiousness ( $r = .457$ ) and its facet Industriousness ( $r = .403$ ), which is indicative of the focus and follow-through a self-directed learner would need. Finally, Self-Directed Learning was also positively correlated with Agreeableness (.465) and its facet, Compassion (.456). While a student who can work autonomously does not require social skills, the relationship may be explained that this type of student is not threatened or competing with other students.

While neither the trait of Extraversion or its dimensions were correlated with Social, the Agreeableness facet of Politeness was negatively correlated with Social. This may indicate that while some learners need interaction with others to be motivated to learn, they are not necessarily interested in the other students' well-being, but having interaction with other learner.

The Motivator Inventory demonstrated weaker correlations with personality. The Motivator scale had weaker correlations – primarily with Extraversion, which can be explained by their need and higher threshold for, stimulation from the external environment. The High Value scale had weak correlations with all traits except Neuroticism. The lack of any correlation between the Motivator Inventory scales and Neuroticism is interesting and may suggest that it is the learning environment, interactions and feedback style, which is most important to motivating this learner type, rather than an externally provided reward.

The results of this study indicate a learner's personality trait composition is related to their motivation trait composition. Identifying a learner's personality composition can provide insights that will support the provision of instruction that is tailored to optimize the learner's motivation. Specifically, personality trait identification can help determine whether the learner is intrinsic and able to learn independently or whether the learner is going to need positive support and encouragement.

## **MAT IMPLEMENTATION IN GIFT**

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The final version of the MAT will be implemented as an actionable survey within GIFT with its implementation functionally aligned with the pedagogical module and long-term learner module (LTLM). Currently, actionable surveys in GIFT use the results of the survey to immediately update the learner model and the pedagogical model, which results in a course adaptation. An actionable survey is scored based on the tags

authored and attached to the concepts addressed by the individual survey questions to create the logic for scoring the survey. The information collected from the survey is sent to the learner model (found in advanced settings) and the scores for the concepts are updated.

Implementation of the MAT will follow the process described above. However, rather than designating a learner as a novice, journeyman or expert, or high or low motivated, the resulting adaptations will be designed to implement a Learner Plan, which will be further described, that will support the learner’s motivation. Furthermore, the results of the MAT will be stored in the LRS and use to select the optimal Learner Plan when the student enters GIFT and launches a lesson. Figure 1 depicts how the MAT actionable survey will be implemented within GIFT.

### MAT Actionable Survey Implementation

The final state of the MAT will be shaped by the results from the present study, as well as the planned verification experiment, which will evaluate the effectiveness of the Learner Plans based on MAT assessment to improve or maintain motivation and learning effectiveness. For implementation within GIFT, the MAT will be created as an actionable questionnaire. Currently, the MAT is divided into sections based on groupings the ITS would need to know such as intrinsic motivation, level of effort, affective tendencies, comparing/competitiveness, task (preference and strategies), reward orientation, and motivator inventory. Extrinsic tendencies will be scored from the reverse of the intrinsic tendencies.

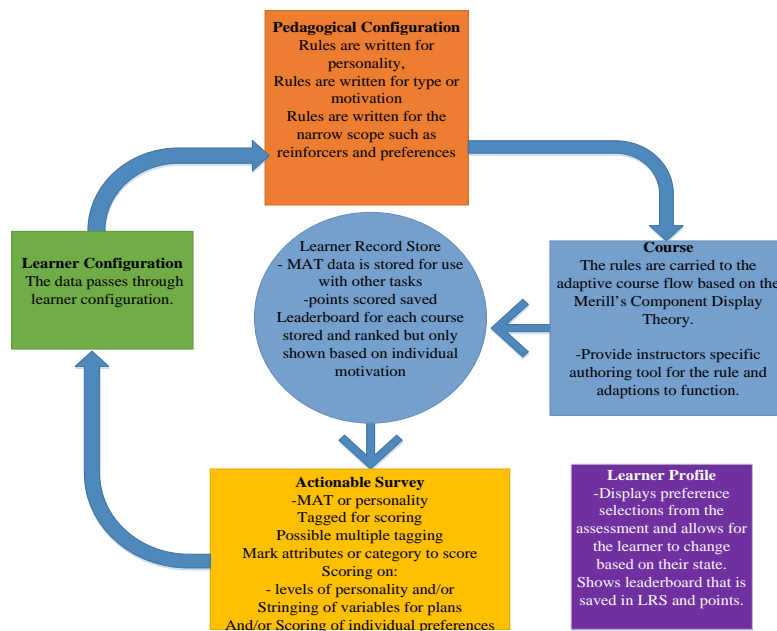


Figure 1. MAT Implementation in GIFT

Based on the results of the analysis presented earlier, as well as the wave 1 and 2 analyses, the final version of the MAT will likely be reduced, focusing on the higher level scales such that only a few Learner Plans may be required, such as Intrinsic/Self-Learner, Threat Vulnerable and Social. For Social, there may be two different plans – one focused on challenge and one focused on reward. For example, the cumulative

scores for these higher-level scales will be made actionable by having specific delivery and pedagogy preferences associated with each scale. A tag will be set to score the various sections from the actionable survey (experiment dependent). For example, Tag 1 would be scored with the Intrinsic (Self-Learner) Learner Plan such that an intrinsic learner's correlates are with a set of variables that need to be scored throughout the assessment and not just based on a few questions measuring one attribute. Tag 2 might be tied to the Extrinsic Learner Plan such that the extrinsic learner will need to provide the personality type (Scenario Developed below for further explanation) to help determine whether they are Threat Vulnerable or Social for instance. Tag 3 might be with additional MAT (e.g., challenge, breaks) or Motivator Inventory sections that will further guide the Social Learner Plan to accurately provide the type of schedule, level of support needed, and so forth (yet to be determined based upon the verification results and synthesis of the wave 1-3 analyses).

The results of the MAT Actionable Survey will need to be stored into the LTLM rather than feed real-time into the pedagogical configuration of the lesson. The next section discusses the LTLM implementation.

### **LTLM Implementation**

In the current version of GIFT, if a lesson has been implemented using an actionable survey, the data is then immediately used to configure the student's lesson in run-time. Therefore, the learner must complete the survey each time he or she takes a lesson Trait information, such as the type of data being obtained by the MAT, is generally fixed for long durations. Repeating the survey each time the learner completes a lesson results in collecting the same data and will serve to demotivate the student. Therefore, we are recommending that the student be asked to take the MAT Actionable Survey the first time they log into GIFT and have the results saved to the long-term learner model (LTLM). Rather than the results directly feeding the pedagogical module during the run-time configuration of the lesson, it can pull the data from the LTLM based on the student's login.

The authors are anticipating that the LTLM will be implemented with a learner record store (LRS). Given the goal of GIFT is to include a LTLM that provides a historical learner model that contains previous learning experience data, as well as data pertaining to individual differences in learning, this project is planning to leverage this future capability. In this way, the LTLM will be used to tailor the pedagogy and delivery mechanisms without requiring the learner to complete surveys each time they enter GIFT to complete a lesson. However, the learner will need to retake the assessment after a period, such as a year, or for major life events that could jeopardize the stability of the trait. Additionally, we recommend that the learner have the option to retake the MAT or other relevant survey at any time if they feel the plan is not right from not answering honestly or a major life event. Some of the information should be shown to the learner on the profile where course history is kept. Students should be able to view the specific outcomes from the MAT scales including motivator preferences

### **Learner Plan Overview**

At the end of Phase I of this project, a set of 4 Learner Quadrants (Intrinsic, High Neuroticism, High Neuroticism with Low Conscientiousness and Low Openness, and Low Conscientiousness and/or Openness) was proposed (Reinerman-Jones et al, 2017), as a means of identifying learner strategies that could be authored in GIFT to support learning motivation based on an assessment of the learner's motivation and personality traits as assessed with the MAT. This present analysis supports Quadrant 1, which resembles the factor of Self-Directed Learning and high levels of Conscientiousness and Openness. These results from this study suggest that Quadrants 2 and 3 can be combined because an individual high in Neuroticism and the MAT factor of Threat Vulnerability is likely to be low in Conscientiousness and Openness. The results in general support Quadrant 4. Further analysis of the MAT scales relevant to the Social factor is warranted

and may provide a way of decomposing into more specific learner plans. For example, competition and challenge are two scales of the MAT associated with the Social factor, so there could be a learner plan focused on including a challenge aspect to learner, such as providing a leaderboard with points or badges. A different learner plan may focus more on providing breaks to the learner. In addition, given the slight correlation to with Neuroticism, the type of social interaction may need to provide supportive interaction.

## Pedagogical Module Implementation

In order to realize the Learner Plans in GIFT, the pedagogical module requires changes so that it can receive input from the LTLM at lesson run-time. The pedagogical module-authoring tool needs to be expanded to support options for the final MAT higher order scales and attributes for the associated learning plans. Figure 4 identifies the parts of the current pedagogical module authoring tool to be modified.

Attributes being considered for the learning plans are intended to promote and improve student motivation. For example, the Intrinsically Motivated (Self-Learner) student's Learner Plans would include: options to write in the learning goal, complete a pre-test, and potentially demonstrate competency and earn credit for the lesson or portion of the lesson and the ability to select their preferred method of task completion (e.g., text, video, game). Whereas, the Learner Plan for a Threat Vulnerable student may include: sub-goals for dividing the lesson into smaller segments, incorporation of positive feedback throughout the lesson and incorporation of relaxation techniques throughout the learning process. Finally, a Social Learner Plan for the Extrinsically Motivated learner who is low in Neuroticism may incorporate: leaderboard for competition with other students, and feedback to help the student maintain focus.

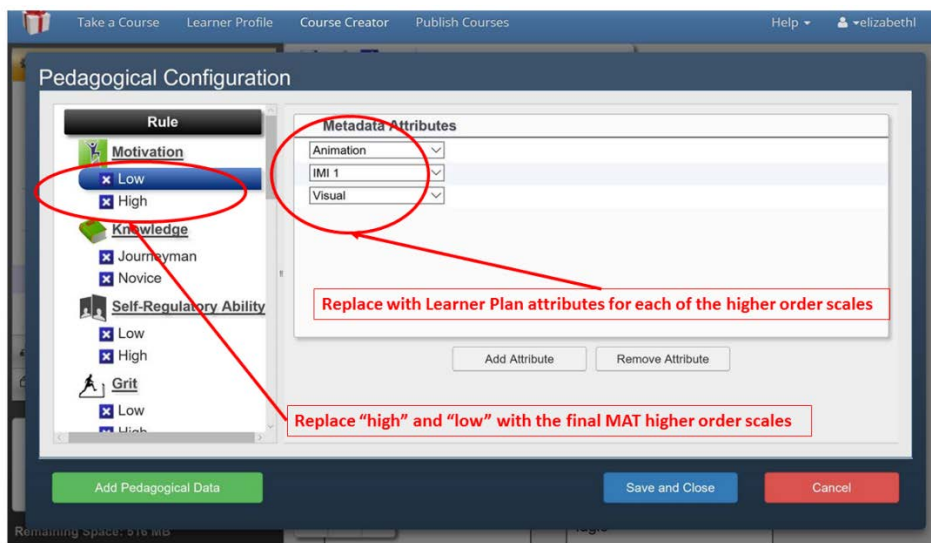


Figure 4. Recommended Modifications to Pedagogical Module Configuration Tool

## CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The results of the study described in this paper provide support that personality is a contributing factor to how a student interacts and performs within a given learning environment. Further, the study provided support that the use of a learner's personality composition can be useful in developing a learning plan to support their motivation. The next step is to further analyze the MAT wave 3 results to better understand the variables that underlie the Social factor.



## **Benefits of GIFT Implementation**

A verification experiment is planned to assess the contribution of Learner Plans tailored to the MAT and personality assessments on mastery level (performance score) and retention of learning. It is anticipated that participants who receive instruction with the Learner Plan associated with their motivation and personality traits will improve their performance and retention, due to an increased level of motivation. With the MAT implemented within GIFT, it will help enable the provision of instruction to the learner in a manner that optimizes their learning outcomes.

## **Barriers to GIFT Implementation**

Implementation of the MAT into GIFT will require some changes to GIFT authoring (configuration) tools and run-time engine. First, the results of the MAT Actionable Survey will need to be stored in a LTLM. Secondly, the pedagogical module configuration tool will need to be modified to support the MAT final scales and Learner Plan attributes. In order to implement some of the attributes being recommended, such as the ability to write in goals or select method of task completion (e.g., game or videos), extensions will need to be made to GIFT to support learning environments beyond those currently supported by GIFT. Finally, the pedagogical module will need to be able to receive data from the LTLM after the student logs into GIFT, rather than pulling the results in run-time from an actionable survey.

## **Summary**

The authors have designed a study to evaluate tailored learning plans that are providing support for Quadrant 1, 2, and 4 in the above model. The results of this study will be used to better inform modifications to the GIFT authoring environment.

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