

IMPACT OF SCIENTIFIC EPISTEMOLOGICAL VIEWS ON GRIT IN PROSPECTIVE TEACHERS

Dr. Anjum Ahmed

Department of Education, Aligarh Muslim University, India. e-mail: anjum.amu1312@gmail.com

Abstract: *Teacher's performance is influenced by the passion and perseverance in the teaching profession, irrespective of the obstacles associated with this prestigious profession. Grit may be crucial at the pre-service level given the struggles one encounters in school, colleges and university level. Having a scientific approach makes one work in a systematic manner with consistency. This study aimed to investigate that relationship and also revisit the role of SEVs in predicting the Grit in prospective teachers. In the study, 100 respondents from Aligarh Muslim University participated in the survey. Tools used in the study were SEV (Scientific Epistemological Views) scale standardised by Liu, S.Y. and Tsai, G. C. (2005) and Grit Scale developed by Edward D. Sturmana and Kerri Zappala-Piemme (2017). The result showed that Scientific Epistemological Views could significantly predict grittiness in prospective teachers. This result shines a new light on the relationship between SEV and Grit of prospective teachers. A group of prospective teachers, who had a high score on SEV or in other words which held an expert/constructivist view on scientific epistemology, were significantly grittier than the group of prospective teachers who were low scorers or held a naïve/empiricist view regarding scientific epistemology. Lastly, there was no significant gender difference in prospective teachers when it came to their Scientific Epistemological Views (its sub-dimensions) and Grit. When it came to Grit, prospective female teachers were grittier than prospective male teachers when their means were compared.*

Keywords: *Scientific Epistemological Views, Grit, Prospective teachers, Gender differences*

1. INTRODUCTION

Teachers are the prime agents in bringing about change in any nation towards globalisation and industrialisation. With this huge responsibility resting on the shoulders of teachers, they are hence believed to be the backbone of any educational institutions in improving the standards of the teaching profession. The teaching profession is a very demanding career that requires an extensive perspective in enthusiasm, commitment and passion. Teacher's performance is influenced by the passion and perseverance in the teaching profession, irrespective of the obstacles associated with this prestigious profession.

Teachers who are the agents of social change are dampened by significant issues which threaten their professional stature and esteem. In this post COVID scenario, the most disturbing issues that most of us are struggling with is employment. With the social and economic recession, the direct impact is on employment in the education sector. This is why every individual is struggling to get hold of any decent job.

It is perceived that in spite of our intelligence, some accomplish more than the other. The researches reviewed in this paper have suggested that one personal quality that is shared by most successful personalities is Grit.

1.1 Teacher Grit

During these struggling times, we need to hone this quality to achieve our objectives. The definition of grit is derived from Bandura's social cognitive theory (Dobbins, 2016). Grit stresses the understanding of other people's actions and activities and sets out conditions for the implementation of these behaviours (Roberts, 2009).

Technically, grit is described as the characteristic degree of perseverance and passion for achieving long-term goals in the midst of challenges (Duckworth et al., 2009; Gerhards, 2015). Grit is a type of bravery that moves people to overcome the fear of failure (Duckworth et al., 2009; Maddi, 2012). These researches have concluded that Grit is necessary to equip pre-service teachers with the dispositions and confidence to handle stressful situations and persevere. Both growth mindset and Grit maybe even more crucial at the pre-service level given the struggles one encounters in school, colleges and university level. Dewek and Legget (1988) have stated that students' achievement goals are influenced by their belief systems, including their personal epistemological theories (Pintrich, 2002). Another variable in this study is Scientific Epistemological Views. The crucial component of scientific literacy is to develop adequate understandings about the nature of science (American Association for the Advancement of Science, 1993). In general, prospective teachers' epistemological beliefs and specifically their scientific epistemological beliefs may determine the way they approach and how they value or disapprove information that is presented to them during their professional training (Fives & Buehl, 2008). The teacher education program should aim to educate pre-service teachers on scientific methods (Shim et al., 2010). The pre-service courses should make the teachers more knowledgeable about the methods of scientific inquiry (İnan, 2011). With the help of different epistemological concepts, one can explain different domains of knowledge. The epistemological concept they develop often reflect the intellectual discourse of school subjects that they have experienced (Smith & Wenk, 2006). Researches have suggested that the learners' epistemological

views of science may influence the acquisition of scientific knowledge (Songer & Linn, 1991), and construct their orientations to learning science (Tsai, 1998a, 2000b; Lederman, 1992; Edmonson & Novak, 1993). It is apparent that SEV is a crucial marker for educators to predict students' learning and to lay the groundwork for science instruction (Tsai 2002).

According to Tsai's study, there are two views regarding scientific epistemology one is the constructivist oriented SEVs/the expert view which assert that scientific knowledge is an invented reality. It is established through the use of agreed theories, shared forms of evidence, and social negotiations in the scientific community. Therefore, Edmond and Novak (1993) have stated that science teachers asserted that science instruction should aim to promote students to acquire constructivist-oriented epistemological views toward science. The post-positivist arguments related to the nature of scientific knowledge question the absolute objectivity, universality and value-free assumptions and focus on the constructivist and contextual aspects of scientific knowledge (Tsai, 2000; Yang, 2005). On the other hand, according to the empiricist (or positivist) view science is a process of individual analysis and exploration. A traditional perspective views scientific knowledge as to be objective, based on control of nature, replicable, value-free, empirical, and universal. Positivist (empiricist - traditional) and post - positivist (constructivist – no - traditional) views of science, clouds one's scientific beliefs, especially the perceptions concerning the researchers' role (Gallaher, 1991). Mainly depending on personal efforts and that scientific knowledge is derived from absolute, unbiased observations and procedures. It also defies the idea that science provides the truths of nature.

Another critical thing to note is that research by Bybee (2015) had suggested that pre-service teachers who had prior knowledge of research methods were less likely to adopt traditional views of science. One needs to acquire knowledge on the fundamentals of science and then only can he be competent to apply that knowledge to life situations. Having a scientific approach makes one work in a systematic manner with consistency. This consistency is where the concept of Grit has to be studied. The relation between scientific epistemological views and Grit of pre-service teachers has not been considered as yet. This study aimed to investigate that relationship and also revisit the role of SEVs in predicting the Grit in prospective teachers.

1.2 Research Questions

The following questions crossed the mind of the investigator as to how our scientific epistemological value impacts one's grittiness.

- What is the relationship between SEV and grit among prospective teachers?
- Is there a gender difference in the SEV and grit of prospective teachers?
- Does the SEV of prospective teachers impact their grittiness?
- Do the grit of prospective teachers differentiate due to their SEVs?

1.3 Objectives of the study

The following objectives were framed according to the research questions:

1. To study the relationship between SEV and grit among prospective teachers.
2. To study the gender difference in prospective teachers' SEV and grit.
3. To study the impact of SEV on the grit of prospective teachers.

2. METHOD

The research is a descriptive type of research. It is based on a survey of the samples' opinion.

2.1 Participants

In the study, 100 respondents participated in the survey, and 100% completed the survey. Participants were from Aligarh Muslim University. Out of 100 responding participants, 50 (50%) were male, and 50 (50%) were female. Among the total, 60% belonged to (20-25) age group, and 40% belonged to (25-30) age group. Of the 100 responding participants, 55% were from science stream, and 45% belonged to non-science stream

2.2 Data Collection Tools

S.E.V. (Scientific Epistemological Views) scale: was standardised by Liu, S.Y. and Tsai, G. C. (2005). The tool comprised of 25 items framed on a five-point Likert scale (1- never and 5- always). The items of the scale were based on five dimensions namely: Role of social negotiation (SN); The inventive and creative nature of science (IC); The theory-laden exploration (TL); The cultural impacts (CU); and The changing and tentative features of science knowledge (CT) The internal reliability of each dimension of this scale is 0.71, 0.60, 0.68, 0.71 and 0.60, with an overall alpha value of **0.67**. The alpha coefficient for the five subscales ranged between 0.56 and 0.75 with 0.76 as total value. The validity of the scale is **0.76**.

Grit Scale: The grit scale was developed by Edward D. Sturmana and Kerri Zappala-Piemme (2017). It consists of 12 items based on the five-point Likert scale (1- never and 5- always). The items corresponded to sustaining a focused effort to achieve success in a task, regardless of the challenges, and the ability to overcome setbacks. The Grit Scale for Children and Adults (GSCA)

was validated in a sample of school and college students and community members. The internal consistency of the GSCA with Cronbach's alpha is **0.84**. The test-retest reliability was **0.78**.

3. RESULT AND DISCUSSION

The means and standard deviations for all the measures were reported in Table 1 and correlations were reported in Table 2.

the female on SEV sub-dimensions. There are some similar contradictory studies which have implied that female students tended to show less confidence, lower interest and participation in learning science than male students (Jovanovic & King, 1998; Kenway & Gough, 1998; Trankina, 1993). Abd-El-Khalick and Lederman (2000) have also indicated that college students' epistemic views about science were not related to their

| Variables | Sample | N | Mean | SD | Df | t | Sig Value | Remark |
|---------------------------------------------------------|--------|-----|-------|-------|----|-------|-----------|-----------------|
| SEV- Scientific Epistemological Value | Total | 100 | 88.94 | 11.21 | | | | |
| | Male | 50 | 87.38 | 12.91 | 98 | -1.39 | .168 | Not Significant |
| | Female | 50 | 90.50 | 9.25 | | | | |
| SN- Social negotiations in the science community | Total | 100 | 3.86 | 1.701 | | | | |
| | Male | 50 | 3.84 | 0.96 | 98 | -1.40 | .168 | Not Significant |
| | Female | 50 | 3.87 | 1.03 | | | | |
| IC- Invented and creative nature of science | Total | 100 | 3.57 | 1.12 | | | | |
| | Male | 50 | 3.49 | 1.21 | 98 | -1.39 | .165 | Not Significant |
| | Female | 50 | 3.65 | 1.01 | | | | |
| TL- Theory-laden exploration | Total | 100 | 3.22 | 1.14 | | | | |
| | Male | 50 | 3.41 | 1.11 | 98 | .840 | .403 | Not Significant |
| | Female | 50 | 3.09 | 1.15 | | | | |
| CU- Cultural impacts | Total | 100 | 3.54 | 1.10 | | | | |
| | Male | 50 | 3.44 | 1.21 | 98 | -.136 | .882 | Not Significant |
| | Female | 50 | 3.70 | 0.96 | | | | |
| CT- Changing and tentative feature of science knowledge | Total | 100 | 3.34 | 1.10 | | | | |
| | Male | 50 | 3.25 | 1.15 | 98 | -1.38 | .170 | Not Significant |
| | Female | 50 | 3.42 | 1.11 | | | | |
| Grit | Total | 100 | 41.45 | 6.55 | | | | |
| | Male | 50 | 40.50 | 6.95 | 98 | -1.46 | .148 | Not Significant |
| | Female | 50 | 42.40 | 6.04 | | | | |

Source: Realized by author

Table 1 tabulated the result of descriptive statistics, and the t-test revealed that there was no significant gender difference in prospective teachers when it came to their SEV (its sub-dimensions) and Grit. On a closer look at the result tabulated it was found that female prospective teachers' SEV had a higher mean (M= 90.50) as compared to prospective male teachers, whose average were below the average (M= 87.38). As far as the SEV sub-dimensions are concerned, the prospective female teachers had the edge over prospective male teachers in all the sub-dimensions except the dimension TL – *Theory - laden exploration*. Quite contrary to the findings of Tsai (2012), where the male had a higher average than

gender. Results obtained from the SEV tool implied that the dimension SN- *Social negotiations in the science community* was the vital element of the prospective teachers' beliefs/views. This finding is slightly different from the previous study (Tsai & Liu, 2005) in which *the theory-laden aspect* was the core concept.

When it came to Grit, prospective female teachers were grittier than prospective male teachers when their means were compared (M=42.40 versus M=40.50). The findings that females are more perseverant than males have been reported in various studies (Christensen & Knezek, 2014; Rogoza et al., 2017; Kaur, 2019 and Kumar, 2019)

Table 2: Correlation of Grit and Scientific Epistemological Value (with its sub-dimensions)

| Variables | SEV | SN | IC | TL | CU | CT | Grit |
|---------------------------------------------------------|-----|--------|--------|--------|--------|--------|--------|
| SEV- Scientific Epistemological Value | 1 | .671** | .684** | .580** | .450** | .728** | .635** |
| SN- Social negotiations in the science community | | 1 | .188 | .376** | -.009 | .293** | .375** |
| IC- Invented and creative nature of science | | | 1 | .288** | .347** | .384** | .320** |
| TL- Theory-laden exploration | | | | 1 | -.001 | .332** | .414** |
| CU- Cultural impacts | | | | | 1 | .238* | .249* |
| CT- Changing and tentative feature of science knowledge | | | | | | 1 | .631** |
| Grit | | | | | | | 1 |

Source: Realized by author

Note. * $p < .05$; ** $p < .01$

According to table 2, Grit had a significantly high strong positive relationship with SEV, $r(98) = .635$, $p < .001$ and with *Changing and tentative feature of science knowledge*, $r(98) = .631$, $p < .001$. The only dimension with which Grit had the lowest yet significant relationship was *Cultural Impact*, $r(98) = .249$, $p < .005$. The result shows that the prospective teachers who were grittier were likely to appreciate the social negotiations in the science community and to understand the changing and tentative feature of Science knowledge. To them, science is always changing. When new findings are

cultural dependent nature of the development of scientific knowledge. It means the belief that different cultural groups have different ways of gaining knowledge about nature is low.

Table 3 showed the relative influence of SEV on the prospective teachers' grit. A bivariate regression was conducted to examine how well the scientific epistemological views could predict grit in prospective teachers. Table 2 has already shed light on the correlation between SEV and grit, which was statistically significant, $r(98) = .635$, $p < .001$. Table 4 has helped to generate the regression

Table 3: Relative influence of SEV on prospective teachers' Grit

| Analysis of Variance | | | | | | |
|----------------------|---------------|----|-------------|--------|------------|--------------------------|
| | Sum of square | Df | Mean square | F | Sig. Value | Remarks |
| Regression | 1714.538 | 1 | 1714.538 | 66.303 | .000 | *Significant $P < 0.005$ |
| Residual | 2534.212 | 98 | ----- | ----- | ----- | ----- |
| Total | 4248.750 | 99 | ----- | ----- | ----- | ----- |

Source: Realized by author

Table 4: Unstandardized and standardised regression coefficients for regression analyses predicting Grit

| Model | Unstandardised Coefficient | | Standardised Coefficient | t | Sig. | Remarks |
|------------|----------------------------|-----------|--------------------------|-------|------|--------------------------|
| | B | Std Error | Beta | | | |
| (Constant) | 8.654 | 4.060 | ----- | 2.132 | .036 | ----- |
| SEV | .369 | .045 | .635 | 8.143 | .000 | *Significant $P < 0.005$ |

Source: Realized by author

revealed, some existing theories may be changed. Contemporary scientific knowledge does not provide the final answer for nature. It will be refined with time. This is where perseverance or Grit is a crucial requirement for comprehending the changing and tentative feature of science knowledge. On the other hand, the very same gritty nature that is accepting the changing nature of science does not comply well enough with the

equation for predicting the grit from SEV. The equation generated was

$\hat{Y} = 8.654 + 0.369x$ ($x = 4.060$ or $.045$). The R^2 for this equation was $.404$; that is, 40% of the variance in grit was predicted from the level of SEV. This is a moderately strong relationship (Cohen, 1988). It is predicted that a 1% increase in SEV will increase grit by $.36\%$.

Table 5: t-test scores of Grit between high scorers and low scorers on SEV

| Variable | Sample | N | Mean | SD | t | Df | Sig. Value | Remarks |
|----------|------------------------|----|-------|------|-------|----|------------|-------------------------|
| Grit | High SEV (Expert View) | 57 | 44.24 | 5.24 | 5.622 | 98 | .000 | *Significant P<0.005 |
| | Low SEV (Naïve View) | 43 | 37.74 | 6.30 | | | | |

Source: Realized by author

Table 5 contains the result of t-test between the two groups. The independent sample t-test was associated with statistically significant effect, $t(98)=-5.622$, $p=.000$. It was found that in a group of prospective teachers, who had a high score on SEV or in other words which held an expert/constructivist view on scientific epistemology, were significantly grittier than the group of prospective teachers who were low scorers or held a naïve/empiricist view regarding scientific epistemology ($M = 44.24$ versus $M = 37.74$ respectively).

Teachers' epistemological beliefs were related to their beliefs about teaching and learning. The findings of this study are consistent with Roth and Weinstock (2013) study which explained that the pre-service teachers reported more sophisticated epistemological beliefs over time in a qualitative analysis and they described teaching on a relational basis from a transformative (constructive) perspective. When the teachers have relativistic epistemological beliefs, they think teaching is not the sole transmission of knowledge; instead, it is a productive process.

According to the study by Wandersee et al. (1994) for 'successfully changing teachers' positivist - oriented SEVs, science educators need to have appropriate instructional strategies as well as require more time and *continuous efforts* for teachers' change'. This '*continuous efforts*' in Wandersee et al. study is the Grit variable that is considered in this study. The study supports the findings that to develop one's grit, nurturing constructivist view of scientific epistemology is one of the prerequisites.

The result is also supported by Fabelico and Afalla (2020) study that teaching performance of teachers is predicted with a high degree of accuracy based from their very satisfactory performance in the knowledge of subject matter and management of learning.

4. MAJOR FINDINGS

The main objective of the study was to find the impact of SEV on Grit of prospective teachers. The result showed that Scientific Epistemological Views could significantly predict grittiness in prospective teachers. It is predicted that a 1% increase in SEV will increase grit by .36%.

This result shines a new light on the relationship between SEV and Grit of prospective teachers. A group of prospective teachers, who had a high score on SEV or in other words which held an expert/constructivist view on scientific epistemology, were significantly grittier than the group of prospective teachers who were low scorers or held a naïve/empiricist view regarding scientific epistemology. This result supports the findings of Wandersee's study that having constructivist SEV will enhance continuous efforts or grittiness is necessary, for teacher's change.

Grit had a significantly high strong positive relationship with SEV and with *Changing and tentative feature of science knowledge* (a sub-dimension of SEV). The only dimension with which Grit had the lowest yet significant relationship was *Cultural Impact*. This showed that the prospective teachers who were grittier were likely to appreciate the social negotiations in the science community and to understand the changing and tentative feature of science knowledge. To them, science is always dynamic. When new findings are exposed, some existing theories may be replaced. Contemporary scientific knowledge does not provide the final answer for nature. It will be refined with time. This is why perseverance or Grit is a crucial requirement for comprehending with the changing and tentative feature of science knowledge. On the other hand, the very same gritty nature that is accepting the changing nature of science does not comply well enough with the cultural dependent nature of the development of scientific knowledge. It means the belief that different cultural groups have different ways of gaining knowledge about nature is low.

Lastly, there was no significant gender difference in prospective teachers when it came to their Scientific Epistemological Views (its sub-dimensions) and Grit. On closer analysis, it was evident that the female prospective teachers' SEV had a higher average as compared to prospective male teachers. As far as the SEV sub-dimensions are concerned, the prospective female teachers had the edge over prospective male teachers in all the sub-dimensions except the dimension TL- *Theory-laden exploration*. Results obtained from the Scientific Epistemological Views tool implied that the dimension SN- *Social negotiations in the science community* was the critical element of the prospective teachers' beliefs/views. When it came

to Grit, prospective female teachers were grittier than prospective male teachers when their means were compared. This could be one of the reason that in teaching professions, we find female teachers in a vast majority, especially in India. Their hard work, commitment and dedication are more evident in the teaching profession, especially at the school level.

5. SUGGESTIONS AND CONCLUSION

As Samarapungavan et al. (2006) have pointed out that students' epistemological views are subjected to undergo change as they move from high school through higher education to become practitioners of some academic fields (e.g., scientists). Therefore SEV can be inculcated or enhanced even later in their higher education courses if the programmes support the training in scientific epistemology beliefs.

The findings of Chinn and Malhotra (2002) holds the assumption that a constructivist view of science is a prerequisite of good science teaching; therefore, teacher education programs should be devoted to help the prospective teachers to develop sophisticated epistemological understandings of science. Linn and Eylon (2000) revealed an important finding that students with constructivist-oriented SEVs tended to attain better science learning outcomes than those with empiricist-aligned SEVs. Hence learners' consistency and perseverance are necessary to make constructivist-oriented SEVs sustainable.

Teachers' beliefs suggested that epistemological beliefs affect curricular and pedagogical decisions (Brickhouse, 1990). Therefore, teacher educators need a better understanding of what kind of epistemological beliefs pre-service teachers hold and how these beliefs change and develop (Schraw, 2001).

Prospective teachers are potential teachers whose epistemological beliefs might be projected into their future teaching, the Teacher Training Institutes or Departments should provide instructional environments that can help the learners develop more sophisticated epistemological views. Prospective teachers with sophisticated epistemological views will not be afraid to take try and take the risk. This attitude and view, along with Grit, will help them to push through difficult times and realize they are capable of learning. Through hard work, they can meet their goals and ultimately taste the true essence of success.

Grit is an important life skill to develop in all ages. Prospective teachers should be trained to develop and manifest this skill in their behaviour. Grit is a symbiosis between passion and perseverance (Duckworth and Seligman, 2009). A teacher with this strength can develop a culture that is resilient to

a tough situation, and in this culture, motivation to keep going becomes of prime importance.

Prospective teachers should be trained in more constructivist approaches, and in-service support should be provided for effective implementation of constructive practices in the classrooms. It is only when they know how to apply their scientific views and beliefs will it act as a catalyst and make one passionate and resilient when things go out of hand.

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